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CONTENTS.

An Asterisk (*) denotes an illustrated article.

EDITORIALS—

Briefly Told 285
The Signs of the Times—Notes.

Effect of Gas Stoves on Coal Traffic in England 286

*The Chemical Constitution of Gas Enrichers, and its Relation to their Enriching Value, by Mr. Wilfrid Irwin, F.C.S. 286

*The Jerzmanowski Process-Apparatus for Producing Gas 290

Selection of High-Speed Engines for Electric Lighting, by Mr. F. W. Richart 291

*The Weber Gas Engine 293

Hints about Injectors for the Engineer and the Fireman 293

Transmission of Heat Through Boiler Plates 294

The Coal Fields of Alabama 295

Hydraulic Power for Digging Foundations 295

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 296
Mr. Eilbeck to Manage the Welsbach Commercial Company—Public Lighting, Knoxville, Tenn.—Something about the Washington C. H. (O.) Company—"Observer" Makes a Correction—Tar Wanted—Gas Plant for Bennington, Vt.—Annual Meeting, Ipswich, Mass.—Inviting Bids for a Gas Franchise—More Main Pipe for Concord, N. H.—Public Lighting, San Francisco—Combination at New Castle, Pa.—Cheaper Gas for Davenport, Ia.—Rules for Gas Piping, Pasadena, Cal—And Other Items.

The Market for Gas Securities 298

BRIEFLY TOLD.

THE SIGNS OF THE TIMES.—It might be said with seeming truth that midsummer is the season of the gas man's greatest discontent, for long hours of natural lighting, added to the muggy discomfort of steaming July and August days, have no attraction for him, in that such conditions deter the user of his product from making many drafts thereon. It is true that that was the case 20 years ago, as to both chapters; but to-day it is true of only one of them. The long hours of natural lighting are still as potent in keeping down the gas sendout as they ever were; not so, however, the muggy discomfort of steaming July and August days, which now are firm friends and aids of the gas maker. Be the seasons hot or cold, wet or dry, fair or foul, man must be fed, and that he may be fed not all the one way, that which he is to eat must be prepared, which preparation involves the aid of heat. This brings us to the gas stove or range, apparatuses that have been and are almost of untold value to the gas industry in the way of developing a demand, continued and steady, for the use of gas in the hot season, and in the daytime thereof. It is with satisfaction that we say that the gas industry of the country is now fully alive to the importance of seeing to it that this branch of their business receives the attention that it merits, and is no longer regarded as an ephemeral or spasmodic growth. In fact, we know of only one large city in the States where the development of the use of gas for fuel has been neglected; and, strange to say, the city in question looks to be peculiarly well instanced for a good, round business on this account, in that gas is measurably cheap there—and it is our belief also that in the average candle power of the gas supplied there it stands second only to New York—and that the climatic conditions are favorable for the fuel use of gas. The city is Baltimore, Md., in which we venture to say the proportion of gas sold on fuel account to total output is smaller than in any other place that could be named, where the annual gas consumption amounts to 100 millions cubic feet. Of course, there may be conditions existing in Baltimore which would explain this satisfactorily; but failing to know them, we can only take the face of things for our guide. As said before, the normal status appears to be on the favorable side for the use of gas for cooking, for not only are the climatic conditions of the right sort, but the residents are of the class who like comfort and appreciate the means of obtainmg it at a cost commensurate only with the benefits accruing. The gas rate, too, is a fairly low one, which all the more mixes one up in attempting to discover or explain how or why it is that the first city in the Union to support a gas company should be the last one to appreciate to the full the benefits that are inherent to the householder in fuel gas. However, if Baltimore is the laggard now, there's time to mend her pace; meanwhile one sign of the times is that gas for cooking, great as has been the development in that line in the past 10 years, will be in wider favor—percentage favor, we mean—in 1900 than it is now; and what more satisfactory outlook do we need?

Another sign of the times, which urgently shows that incandescent electric lighting is not up to the promises of its furnishers, comes out in the astonishing amount of work that has been done by gas companies in two years—particularly in the current year—in the matter of main extensions. We have reports from 271 different points where, during the present season, main extensions, to the length of 2,096 miles, have

been arranged for. We submit that this statement exceeds any expectation of ours when we started to collect the statistics, for it needs no exceeding great expert in mathematics to determine that this means the placing by 271 companies, large and small, of an average of over 7 miles of *additional* pipe. Quite a bit of this increased mileage went to connect up outlying suburban districts, or in boroughs of names and under government distinct from the places in which the manufacturing plants are located. To go back of or behind this indicates that such "connecting up" virtually means the putting in operation of several new gas plants, and further proves that both investors and the communities to be served by them are alive to the benefits resulting from a reasonable exercise of concentrated power. Saying that also recalls to mind many situations in this State, in Connecticut and Massachusetts, where a like plan of "connecting up" could be profitably followed. Another extremely satisfactory feature of the returns is found in the knowledge that only 12 places out of the 271 acknowledged the placing of any pipe of a diameter less than 3 inches. An unsatisfactory feature, however, of the statistics is that which shows that the pipe mileage in the South and Southwest has not been sensibly added to. Putting all things so far reported in comparison, respecting the outlook for the trade, we believe that the gas business of America is on a sounder footing now than any heretofore trod by it.

NOTES.—Mr. Thos. J. Walsh, who has been in charge as foreman of the "lower gas works" of the Richmond (Va.) plant for some years (his connection with the Richmond works in one capacity or another covers a period of 25 years), has been removed. Superintendent Knowles in dismissing Mr. Walsh, said that "outside pressure" demanded his (Walsh's) removal.——The executive offices of the Bay State Gas Company, of Delaware, which have for some time been located in the Drexel Building, Philadelphia, are to be removed to suitable quarters in the Bayard Building, Wilmington, Del. It is also on the cards that the offices of the Staten Island Terra Cotta Lumber Company will be located in the Bayard Building. Does Mr. Addicks at last see the benefits that come from centralization, rather than from delocalization?——The property hitherto held by the Washington (D. C.) Gas Company, under leasehold from the Chesapeake and Ohio Canal Company, is now held in fee simple by the former through purchase.——The new purifying plant of the Chicopee (Mass.) Gas Company will be completed by October 1st.——The experiment at Bogota, N. J., which place is on the east bank of the Hackensack river, directly opposite Hackensack, of lighting the streets by means of Welsbach lamps, is quite a success. The Hackensack Gas Company is supplying the illuminating medium through the pipe recently laid under the river by Mr. Elliott, and we would respectfully call the attention of the authorities of Hackensack to the difference between the lighting effect on the Bogota side of Welsbach lamps and that of the incandescent (?) electric lamps doing duty in some of the side streets of Hackensack. Of course, we know that the Hackensack Gas Light Company is also in control of the electric lighting supply of that place.——In 1894 the manufacturers of the Cabot trays for gas works filled orders for their specialties from no less than 75 different gas works.

Effect of Gas Stoves on Coal Traffic in England.

The London *Journal* remarks it is not often that gas supply figures in the proceedings at the half-yearly meetings of the great railway companies; yet it has done so lately at those of the Great Eastern Railway Company. Addressing the shareholders last month, Lord Claud Hamilton had to announce a falling off to the extent of $180,000 in the Company's coal traffic, in spite of the increase which has taken place in the population in their district. He attributed this mainly to the diversion of trade caused by the great coal strike of 1893; but another cause was, he said, the substitution of gas and oil stoves for open grates—a change which was really working a silent revolution in the domestic arrangements of large masses of the people.

His Lordship went on to say that, in the suburbs which the Company served, he found the large Gas Companies estimated that they had 90,000 gas stoves hired, as against 80,000 at the end of 1893; and they were steadily increasing. Therefore, taking the number of stoves mentioned, it meant about 90,000 tons of coal less consumed in the district served by these companies; and the bulk of this coal would have been carried by them. The same tale came from the large towns and country districts. This movement really began in earnest during the coal strike of 1893. The miners were led into the strike under bad advice, regardless of the inconvenience they would cause to the public and to their fellow laborers in other industries; and their fellow-laborers were driven to obtain fuel other than coal. Thus the heaviest blow which the consumption of household coal had received had come, not from the capitalists or the "classes," but from the miners themselves.

The Chemical Constitution of Gas Enrichers, and Its Relation to Their Enriching Value.

[Read by Mr. Wilfrid Irwin, F.C.S., before the Manchester Section of the Society of Chemical Industry.]

So very much has been written of late on the theory of luminous combustion, and the influence of the various components of a gas on its illuminating power, that it may seem presumptuous for a comparative stranger to enter a field where so many chemists of standing and ability are already engaged, and are daily making new additions to our knowledge on the subject; for, though it is now nearly a hundred years since the manufacture of gas for lighting purposes was first introduced on a commercial scale, it is only very recently that any scientific knowledge of the cause of luminosity has been forthcoming. The widespread ignorance of the composition of illuminating gas may be gleaned from the fact that in very few of even the later text books is any mention made of its most important illuminant, benzene—a substance which is now being manufactured on an enormous scale. Its history may be found in Lunge's treatise on "Coal Tar and Ammonia" (1887), p. 114, and in Roscoe and Schorlemmer's treatise on "Organic Chemistry," Vol. III. (1886), p. 64.

In the year 1882, the price of 90 per cent. benzol having risen to $3.75 per gallon, Mr. Josiah Hardman suggested to me the advisability of experimenting on this process. A few trials soon showed me the right course to pursue; and the results were truly startling. I found that as much as 3½ gallons of benzene could be produced from 10,000 cubic feet of Manchester gas; or, in other words, of all the benzene formed in the process of coal carbonization, only from 3 to 5 per cent. remains in the tar—the rest going forward into the gas, and supplying a great part of its illuminating power.

Plant was immediately erected, and within a very short time several hundred gallons were actually extracted from the corporation gas, the residue being employed as fuel. Large carbonizing works were also soon in course of construction, and the commercial bearing of the case may be gauged from the fact that at that time 1 ton of coal, costing $1.50, with labor (say) $1, would produce $7.50 worth of benzene, in addition to other bye-products.

There occurred to me about this time an idea to make an arrangement with gas companies for the extraction of benzene from their gas, and to replace the illuminating power lost thereby with light petroleum spirit, the former being about eight times the price of the latter. I soon found, however, that at least three times the amount of spirit was required to repair the loss of a certain quantity of benzene, and that there was also great difficulty in getting the required amount into the gas without condensation. These facts, combined with the rapidly falling price of benzene, soon rendered the suggestion quite impracticable. Mr. G. E. Davis afterwards brought out a process in which he cooled the gas before absorption; and Mr. S. Mellor, one for obtaining the benzene by compression. So that Manchester and benzene are somewhat intimately associated.

In the years succeeding, from the small beginning above mentioned (largely owing to the increase in the number of coke ovens of the Simon-Carvès type, especially in Germany), the supply of benzene has outstripped the demand. The price now [May 24] stands at 25 cents a gallon; and unless some new requirement can be found for it, it appears likely to remain there. It was in connection with experiments on its efficiency as a gas enricher that I was led to take up the line of investigation I am about to describe.

Methods Employed for Conducting Experiments on Gas Enriching.—This, to begin with, is no easy matter, as the contact of ordinary coal gas with water was found to cause a rapid diminution in illuminating power, so that known mixtures in ordinary gasholders could not be obtained. An experiment will illustrate this. Take a large bottle half filled with water and the remainder with Manchester gas of 19 to 20-candle power. Agitate the two together, and then test the gas again. It will be found to have fallen from 19 candles to 1 candle with a union jet burner, or to 2 candles with an Argand.

This fact could only be due to the solubility in water of the benzene and olefines; and as the former is described in the text books as practically insoluble in water, I determined to settle the matter by experiment. The result was just what one would expect, and was as follows: 1,000 volumes of water dissolve 1.45 volumes of benzene.

As a little digression, I resolved to compare it with toluene and xylene in this respect. You may be aware of the fact that the addition of CH_3 in the aromatic nucleus decreases the solubility. Thus aniline is more soluble than toluidine. Phenol is more soluble than cresol, and this again than xylenol; and it appeared interesting to discover if the base

of all these bodies followed the same law. This was found to be the case. As I said before, 1,000 parts of water dissolve 1.45 parts of benzene, 0.57 part of toluene, and 0.12 part of xylene. In comparison with the foregoing, heptane was found practically insoluble in water.

The method I adopted for the regular and gradual absorption by the gas of an enricher on a laboratory scale was the following: The gas, after being well dried with chloride of calcium, was passed over the enricher—say, pure benzene, and a bye-pass was arranged for the unenriched gas to meet and mix with the enriched gas before passing to the burner for testing. By this means only substances with constant boiling points could be tested; but it appeared the most satisfactory method I could think of for the work I wished to perform.

The first experiments I propose to describe were made with disillumined coal gas—that is, gas from which all illuminating power had been extracted by treatment with fuming sulphuric acid. Such gas, with a union jet burner, tested about 0.03 candle; with an Argand burner, 0.75 candle. With an Argand burner having its air supply checked, it gives a flame of about 5 candles, but difficult to determine, owing to its peculiar color and great length. The gas is practically a mixture of 2 of H to 1 of CH_4. As the union jet burner is the commonest in practical use, all my experiments, except a few specially mentioned, have been made with it; a No. 4 Bray being the one chosen.

Note very carefully the flame we get with this disillumined gas. Next to the jet is a space quite devoid of luminosity; above it, a very slight luminous band; higher up still there is a perfectly dark band; and, lastly, at the very top of the flame is again a fringe of slight luminosity.

To determine the meaning of this, I made the following experiments: I first introduced into the disillumined gas a small quantity of benzene vapor, and noted the change in the flame. I found that the lower slightly luminous portion greatly increased in brilliancy, the result being a comparatively small but very bright flame. I next tried benzene with hydrogen and water gas respectively, and found that the combination in both cases gave a result similar to, but more intensified than that when disillumined coal gas was employed.

I then tried the effect of hexane—an enricher which contains a large percentage of hydrogen, and which, on decomposition in the lower part of the flame, would yield a considerable amount of CH_4. The result of this admixture was that the lower part of the flame was not rendered anything like so brilliant as with benzene, but that the outer luminous fringe was considerably increased in size, so that a large, though not highly luminous flame was the result. The union jet was now replaced by an Argand burner, which doubled the illuminating power of the hexane gas, while the gas enriched with benzene was not greatly altered—say, about 20 per cent.

Professor Lewes' researches seem to point to the fact that most substances which produce luminosity in gas do so by first of all decomposing into C_2H_2 and H; and, further, that the endothermic heat of decom position of C_2H_2 causes a rapid rise in the temperature of the liberated carbon, resulting in the luminosity with which the flame is endowed. When hydrocarbons of the paraffine series are passed through a red hot tube, a large amount of C_2H_4 and CH_4 is produced; the latter being further decomposed by more intense heat into C_2H_2 and H. A less intense heat is required for decomposition of benzene, which, however, also produces large quantities of C_2H_2.

The meaning of the stratification of slightly luminous flames now became clear. When the gas first leaves the jet, it passes through the "baking" part of the flame, where bodies such as C_2H_6 and C_3H_8 are decomposed and form the lower luminous band. In the case of gas treated with sulphuric acid, a trace of C_2H_4 has evidently escaped absorption. As we pass farther up the flame, the temperature naturally rises, until after passing the non-luminous layer, where complete combustion of the liberated carbon has taken place, we ultimately reach a point sufficiently high in temperature to decompose CH_4 with the production of C_2H_2, the decomposition of which again yields the luminous fringe at the top of the flame,

With an Argand burner, the heat of the whole flame is greatly increased. This has little effect on the benzene, as in a union jet there is still sufficient to cause its decomposition into C_2H_2. But with a body like hexane, which on decomposition would yield a large quantity of CH_4, the heat of the Argand is most beneficial, as it causes more CH_4 to decompose into C_2H_2 and H; and therefore very much less has to be spent in merely maintaining the heat of the flame by combustion. I have little doubt that this is the process which goes on in every gas flame, with certain exceptions, to which I will refer later on.

We now come to the figures relating to the action of different quantities of benzene on disillumined gas; and as an example of the details required in each case, I will give the following: Volume of gas employed, 14 liters; volume of gas after the addition of benzene vapor, 14.28 liters; weight of benzene absorbed, 1.267 grammes; time occupied in burning, 7.5 minutes; candles burning at the rate of 119 grammes per hour; candle power calculated to 5 cubic feet per hour, 20.2 candles; benzene contained in a liter of gas burned, 0.088 gramme; benzene required per candle, 0.00434 gramme per liter. The results of the disillumined gas *plus* benzene were—

0.0221	gramme per liter	gave 1.3	candles.
0.0385	"	" 4.1	"
0.0544	"	" 7.6	"
0.0630	"	" 9.6	"
0.0863	"	" 21.0	"
0.0881	"	" 20.2	"
0.1230	"	" 30.0	"

From the above it will be seen that 0.018 gramme per liter is required beyond any effect is produced on the illuminating power of the gas, but that after this point is reached the illuminating power is increased at an average rate of 0.0034 gramme of benzene per candle, or about 4 candles per gallon per 10,000 cubic feet.

With the foregoing I carefully compared the action of heptane (prepared by fractionating petroleum spirit) on the disillumined gas. The following were the results:

0.0528	gramme per liter	gave 2.15	candles.
0.1010	"	" 6.35	"
0.1560	"	" 11.10	"

From the above it will be seen that 0.028 gramme per liter was required before any illuminating action could be produced; but that, after reaching this point, the increase was at the rate of 0.0115 gramme per candle per liter, or about 1 candle per gallon per 10,000 cubic feet.

By comparing these results, I came to the conclusion that the carbon density alone had little to do with the enriching value of the hydrocarbon, but that it was the proportionate amount of carbon and hydrogen in the molecule that was the principal factor in determining its value. I therefore resolved to try the effect of toluol, which (if this theory, which I have since found that Knublauch was the first to put forward, be correct) should be below benzene in its illuminating value:

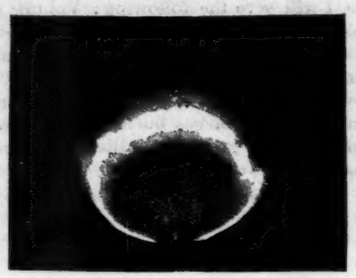
Benzene.	Toluene.	Xylene.	Naphthaline.	Heptane.
C_6H_6	C_7H_8	C_8H_{10}	$C_{10}H_8$	C_7H_{16}.

With toluene I found 0.0033 gramme per liter was required per candle, against benzene 0.0034 gramme, and heptane 0.0115 gramme. This result did not seem encouraging, so I tried xylene, with which I found 0.0027 gramme per liter was required per candle.

This result quite upset the before-mentioned theory, and I began to conclude that the arrangement of atoms in the molecule might have a considerable influence on the enriching power of the hydrocarbons. I therefore tried the effect of naphthaline, and found that 0.062 gramme per liter gave 26.9 candles; 0.059 gramme, 23.5 candles; 0.046 gramme, 21 candles. The average, 0.058 gramme per liter, gave 23.8 candles. After allowing 0.010 gramme for the start, the amount of naphthaline required per candle per liter was only 0.0020 gramme; showing that its enriching power was more than half as great again as that of benzene, and nearly six times that of heptane.

On comparing benzene with naphthaline, as regards structural arrangement, we find that, in the case of benzene, 92 per cent. consists of carbon combined with hydrogen, while in the case of naphthaline 75 per cent. consists of carbon combined with hydrogen, and 18 per cent. of carbon uncombined with hydrogen. From this we may conclude that carbon, in combination only with other carbon atoms, and not linked with hydrogen, is of much greater utility as an enricher than carbon in combination with hydrogen. In other words, far more of the latter gets destroyed—that is, burnt—before the final decomposition of C_2H_2 takes place. As a matter of fact, it is very improbable that the two carbon atoms uncombined with hydrogen ever form C_2H_2 at all, but simply separate into free carbon.

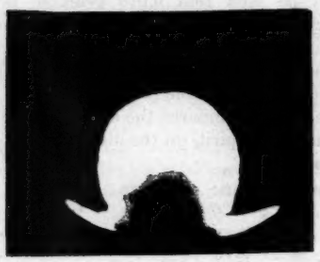
From the above figures we may calculate that carbon in combination with other carbon atoms only is nearly three times as efficacious as carbon in combination with hydrogen. In other words, only one-third of the carbon atoms in combination with hydrogen ever get utilized. So that, even in naphthaline, not more than 44 per cent. of the weight added to the gas is really utilized in emitting light; and since the addition of 0.002 gramme per liter raises the illuminating power of the gas by one candle, the amount of solid carbon engaged in emitting this quantity of light would be 0.00088 gramme; or, in other words, a gas burning for one hour, and giving a light equal to 20 candles, does not employ more than the extraordinarily small amount of 2.58 grammes



DISILLUMINED GAS.—Owing to the quivering of the flame the black band over the lower luminous layer is not very distinct.

DISILLUMINED GAS AND BENZENE.—Showing contracted size of the non-luminous part of the flame.

DISILLUMINED GAS AND HEPTANE.



WATER GAS AND BENZENE.

WATER GAS, BENZENE AND A LITTLE PENTANE.

WATER GAS, BENZENE AND MORE PENTANE.

($\frac{1}{11}$ oz.) of solid carbon actually engaged in emitting light. Experiments on naphthaline and hydrogen, shortly to be described, confirm this result.

From the above considerations, and bearing in mind that, with a union jet, CH_4 and C_2H_6 are non-luminous, we arrive at the following four conclusions: That, in an enricher, a carbon atom combined with H_4 or H_2 is useless; that a carbon atom combined with H_3 possesses enriching power; that a carbon atom combined with H_1 possesses two or three times the enriching power of the foregoing; and that a carbon atom combined only with other carbon atoms again possesses two or three times the enriching power of a carbon atom combined with H_1. These facts easily account for the position toluene and xylene hold with regard to their enriching value.

My next experiment was on the influence of a body possessing a higher percentage than naphthaline of carbon atoms combined only with other carbon atoms. For this I used phenanthrene. Here again I obtained higher values than with naphthaline. But its very high boiling point (350° C.) made it difficult to work with; and my results not being at all constant, I do not care to give them.

I then tried the effect of an oxygen atom in combination with benzene. For this I used phenol (C_6H_5OH)—the results being interesting: 0.020 gramme per liter gave 1.6 candles; 0.0841 gramme per liter, 11.6 candles, or 0.0064 gramme per candle after the start. This was nearly double the benzene figure, and it illustrates the deleterious effect of combined oxygen on the illuminating value of the enricher.

So much for the action of enrichers on disillumined coal gas. Let us now consider their action on hydrogen itself.

Benzene and Hydrogen.—0.068 gramme per liter gave 0.45 candle; 0.096 gramme per liter, 10.05 candles. Hence one candle, after the start, required 0.0028 gramme of benzene.

Hexane and Hydrogen.—0.121 gramme per liter gave only 0.2 candle, though this amount was increased to 1.5 candles with an Argand burner.

Naphthaline and Hydrogen—0.0517 gramme per liter gave 4.3 candles; 0.0872 gramme per liter, 18 candles. Therefore 0.0355 gramme per liter gave 13.7 candles after the start, or 0.0026 gramme per candle per liter.

Mr. Lewis T. Wright, in a paper recently published,* lays great stress on the relation between the total effective carbon vapor (that is, carbon in combination with hydrogen) in any gas and its illuminating power. I would beg to bring before his notice the case of this mixed gas and that of disillumined coal gas. The latter, with a carbon density of 30 per cent., has an illuminating power of at most 5 candles with an Argand burner, (air checked). Naphthaline plus hydrogen with a carbon density of 7.5 per cent. has an illuminating power of 18 candles. This fact, you will see, quite disposes of the theory advanced by some, that a good heating gas and a good lighting gas are practically synonymous terms.

In the foregoing figures there is one point that needs some explanation. In the case of benzene 0.065 gramme, with hexane 0.12 gramme, and with naphthaline 0.042 gramme per liter is required to be sacrificed before any luminosity is forthcoming. Professor Lewes finds the same to be the case with acetylene. He explains it by the fact that the more dilute is the enricher, the higher the temperature required for decomposition; and he assumes that it is the heat of combustion of a certain amount of the enricher that is required, in addition to that supplied by the burning hydrogen, for the decomposition of a further supply of the enricher—say C_2H_2.

Additional proof appears to me necessary, however, to settle this point; for only half the amount of benzene (which has the same percentage composition of carbon and hydrogen as C_2H_2) is required, and only one-third the amount of naphthaline, to produce the same result, and this in spite of the high endothermic property of acetylene.

Again, in a disillumined coal gas flame, where the percentage of carbon is far higher than in any of the above mixtures, a certain amount of benzene is required to be added before any perceptible addition to the illuminating power is obtained.

The only attempt at an explanation that I can give is to suppose that it is merely a question of the ability of a certain amount of the enricher to resist oxidation in the lower part of the flame before it can reach that portion of it which is hot enough to cause complete decomposition with separation of solid carbon. Of course, the latter action will be hastened by the heat of combustion of that portion of the hydrocarbons which is burnt in the lower part of the flame.

It may be noted that, in these considerations, the solid particle theory of combustion is completely upheld; but the theory that it is always the hydrogen in a hydrocarbon that first burns—thus liberating the carbon to form the glow—is unsound, and no longer tenable.

Water Gas and Benzene.

In the preparation of the gas, steam was passed through a tube filled with coke, and kept at a bright red heat. The gas produced contained no air, but 10 per cent. of carbon dioxide, which was removed by treatment with caustic soda. With this gas, 0.079 gramme of benzene per liter gave 0.51 candle; 0.154 gramme, 12.9 candles. Hence, 0.075 gramme of benzene was required before any luminosity could be produced; and after that point was reached, enrichment at the rate of 0.006 gramme per candle ensued. On comparison with previous experiments with disillumined coal gas, these figures tell against the use of benzene with a gas containing a high percentage of carbon monoxide in a general way; but its economic bearing, taking into consideration the rapid rate at which carbureted water gas can be manufactured, I cannot now enter into.

*See JOURNAL, March 18, 1895, p. 363.

Note the shape of the flame of water gas and benzene. It is like an ordinary gas flame without a top to it. This is no doubt due to the fact that little or no CH_4 is present to decompose into C_2H_2 and C at the hottest and highest part of the flame. If, however, we add to this flame an enricher like pentane, which, by itself, in any reasonable quantity, does not add any illuminating power to the flame, but which, on decomposition in the lower part of the flame, would yield a large amount of CH_4, the flame nearly resumes its normal shape.

Benzene with Manchester Gas.

For the action of benzene as an enriching agent on ordinary coal gas, the figures given by authorities on the subject are most widely divergent. The following is a list: Bunte says 1 gallon in 10,000 feet of gas gives 3.6 candles enrichment; Frankland, 2.9 candles; Hunt, 0.9 candle; Knublauch, 3.7 candles; Stenhouse, 1.3 candles; L. T. Wright, 0.8 candle.

The following experiment will suffice to show the effect of benzene on Manchester gas:

	Union Jet.	Argand Burner. Arranged to Give the Most Light.
Manchester gas before enrichment..	12.6 candles.	21.0 candles (approx.)
Benzol added, or rather contained in the enriched gas, per 10,000 cu. ft.	0.075 gramme per liter.	0.079 gramme per liter.
Illuminating power after enrichment	28.6 candles.	23.5 candles.
Gain in luminosity by enrichment..	16.0 "	2.5 "
Gain in illuminating power per gallon per 10,000 cubic feet. Average of three tests.....	2.7 "	0.5 "

Notice the extraordinary effect the burner has upon the results. But, further, these results do not appear to tally, even in the case of the union jet burner, with those wherein disillumined gas was experimented upon; and I can only account for the difference by assuming that a sort of overlapping takes place in the illuminants contained in an ordinary coal gas flame—in other words, that you cannot get the full value of the light-giving power of both the olefines and the benzene when burnt in any proportion together. If this be so, a cubic foot of gas enriched to 20 candles with olefines mixed with an equal amount of gas enriched to 20 candles with benzene, would not necessarily give 2 cubic feet of 20 candles; but the mixture would probably have a lower illuminating power.

The above supposition, if it be correct, must be of the greatest importance to the gas manufacturer, and I hope before long to be able to settle it by experiment. But it is the only explanation I can offer in regard to my own results, and to account for the discrepancies recorded by other observers; the influence of the class of burner used, great as it is, being insufficient. Data recorded relating to enriching values are absolutely useless unless both the composition of the gas to be enriched and the burner employed are stated at the same time.

Manchester Gas with Hexane.

	Union Jet.
Illuminating power before enrichment....	13.2 candles.
Hexane contained in the enriched gas per 10,000 cubic feet.....	0.092 gramme per liter.
Illuminating power after enrichment.....	17.3 candles.
Gain in illuminating power by enrichment	4.1 "
Equal to 0.62 candle per gallon per 10,000 cubic feet.	

The foregoing experiments open up a very wide question. They show that, when the common union jet burner is employed—and I suppose 80 per cent. of the burners used in this country are of that type—gas enriched to a high candle power, when tested in the ordinary manner, is of very little avail, when that enrichment is due to the presence of olefines or rather hydrocarbons with a high percentage of hydrogen. Argand burners are not popular, and slit burners are said to be smoky. So the union jet burner still holds the field.

The lights of Paris, with its 14-candle gas, are often compared with, and said to be equal in illuminating power to those of the North, with gas of 20 to 30 candles. Why is this so? Some say because the atmosphere of Paris is clearer than that of our northern towns, and that therefore the lights shine more clearly; while others try to find a difference between illuminating power and illuminating effect—a distinction I am unable to understand. My own opinion in the matter, and one formed from the experiments here described, is that Paris gas, as Berthelot states, owes its 14-candle illuminating power almost entirely to benzene; so that the consumers really get what they are supposed to do—probably quite as much as we in Manchester get from our 20-candle gas, which is made from cannel (and therefore owes its illuminating power largely to olefines as well as benzene), and which the majority of us consume in burners ill adapted to its use. Gas enriched to 17 or 18 candles with benzene would be far better appreciated than 20-candle gas owing its illuminating power largely to olefines—that is, by the average consumer. The same considerations also hold good for petroleum enrichment as for olefines.

As regards price, benzene at 25 cents a gallon is by far the most economical enricher with a union jet burner; and its production from coke ovens is continually on the increase. Should a great increase in its employment cause a rise in price, the gas works might themselves manufacture it in summer for use in winter, when the market for coke and other bye-products would allow of this being done. But, anyhow, while the price remains at the present figure, it certainly ought to be used for the enrichment of gas.

General Conclusions.

(1) That of all enrichers, benzene, for the average consumer of gas, gives the greatest value for the money.

(2) Toluene and xylene are better enrichers; but their non-volatility precludes their employment.

(3) Naphthaline is the cheapest and greatest enricher; but it cannot be supplied with gas from the gas works because of its non-volatility. It could, however, be used for the street lamps with a carbureting apparatus, which would give 50 per cent. more light for a mere fraction. Were separate mains employed and water gas used in connection with naphthaline, the cost of street lighting would be reduced to a minimum.

Discussion.

Mr. T. Banbury Ball (Rochdale) said, from the practical gas manufacturer's point of view, he differed *in toto* from Mr. Irwin in the method adopted for determining the value of benzol as an enricher. It was undoubtedly quite possible to use benzol in the way described; but there would be great difficulty in securing uniform results. Mr. Irwin's object was to show the value of adding benzol and other hydrocarbons as enrichers to ordinary coal gas; and the gas manager desired to know what, for example, benzol would do when added to 15, 16, or 17-candle gas. It was of little interest to him what its effect might be upon gas deprived of its illuminants, such as Mr. Irwin had used. The fact that an increase of 16 candles had been found when the enriched and unenriched gases were burnt in a union jet burner (and a small one too), though only 3 candles' increase was found when the samples of the same gas were tested in an Argand burner, tended to show that the former was an entirely unsuitable burner for the gas tested before enrichment, and not that the whole improvement was due to benzol. The method adopted by Mr. Irwin, of passing the gas over the surface of the benzol, would probably be found to result in the liquid gradually becoming denser, and the enriching effect diminishing. This was found to be the case when the benzol was volatilized by steam heat, and one would expect it to be much more so when the gas simply carried away the benzol mechanically. Referring to the figures just quoted by Mr. Irwin, as to the values arrived at by Dr. Bunte and others, it was difficult to compare them without knowing the conditions under which the experiments were conducted; and while he should be delighted if the values quoted could be obtained in ordinary working, he was bound to say that as yet they had only been able to approximately reach the figure given by Mr. Stenhouse in his paper read at the previous meeting.[1]

Mr. W. Thomson asked whether Mr. Irwin had made any experiments by burning the different mixtures of gases under pressure or by means of hot air, as in the Wenham burner. He also wished to know if Mr. Irwin could explain the reason why two little wings of light formed at each side of the flame when burning naphthaline as an enricher.

Dr. Lewkowitsch wished to know how Mr. Irwin had estimated the solubility of benzene, as the paraffines experimented on were doubtless of American origin. He suggested that Russian petroleums should be tried, the naphthalines in this petroleum forming an intermediate group between the open-chain paraffines and closed-chain benzenes. As to the theory of the flame, would it not be advisable to burn the gases in Smithell's flame dividing apparatus, and examine the gases?

Mr. H. Grimshaw expressed his disappointment that nothing had been said about acetylene, which, according to recent reports, was coming to the front for enriching coal gas. In his opinion, naphthaline used as an enricher of coal gas was still the cheapest, especially at the present price of about $45 per ton, and he thought the most practical outcome of the discussion would be to ascertain whether acetylene or naphthalene would be the cheaper. In his own mind, he considered that acetylene was not destined to be a rival of the other materials used for the enrichment of coal gas.

1. See JOURNAL, July 22, 1895, p. 128.

Mr. T. Stenhouse thought the paper would have been of much greater interest had Mr. Irwin explained how the experiments had been carried out, the kind of burners and the photometer employed, and whether he had used ordinary coal gas of 15 or 16-candle power or disillumined gas. How was the gas enriched by the naphthaline? Were the enrichers used weighed or measured? The paper contained very little information on these points, though the results appeared to have been calculated out very finely.

Mr. Irwin, in reply to Mr. Ball, said he distinctly stated that his experiments were made with the burner most commonly employed—viz., the union jet. He was fully aware that the Argand burner, which was chiefly used for testing in gas works, had not given high results with benzene. But he regarded the question from a consumer's rather than from a gas manager's point of view, and, so regarded, he considered benzene the most economical enricher. With respect to the carbureting apparatus, he never suggested that the laboratory method he had mentioned could be used on a large scale. Were he carbureting in a works, he would use either such an apparatus as that suggested by Bunte or possibly a simple tower packed like a scrubber, up which the gas might pass and meet and absorb a stream of benzene descending. In reply to Mr. Thomson, the reason regenerative burners gave more light was in all probability that the additional heat supplied caused a greater quantity of marsh gas to be changed into acetylene with less waste in merely maintaining the heat of the flame. In reply to Dr. Lewkowitsch, he had estimated the solubility of benzine in water merely by agitating the benzol and water together, taking the precaution not to allow more air than possible to be admitted into the mixture. Just before the point of concentration the mixture formed a froth, which disappeared again the moment excess of benzene was added. The data given represented volumes of liquid benzene, and not vapor of benzene. With regard to naphthalines, he had not made any experiments with them, but he should expect they would follow, in their carbureting power, the theory he had advanced. In the paraffine series, generally speaking, the higher they were in the series the greater was their enriching value. With reference to Mr. Grimshaw's remarks, he had at first intended to institute comparisons with acetylene, but as the paper was getting lengthy, and acetylene was being put out of the field altogether by its introducer, Professor Lewes, he decided to leave it alone. In reply to Mr. Stenhouse, the kind of photometer employed was one of the Bunsen pattern he had constructed for use in his laboratory. It was not on so elaborate a scale as a gas works photometer, but any error due to the instrument itself would not be sufficient to affect the theory he advanced as to the constitution of enrichers, and its relation to their enriching power. In the case where such bodies as naphthaline were employed, the burner had to be kept in contact with the stopper of the vessel containing the enricher at a constant temperature of (say) 100° C. Trials had to be made at first to find at what temperature the best result could be obtained with the substance to be experimented upon, and afterwards the test made. He had arranged an apparatus by which he could pass a constant stream of gas—say, half a cubic foot—over the enricher. It would be interesting to test the benzene hydrogen gas with a regenerator, in which case he doubted whether the gain in enrichment would be anything like so great as with ordinary gas. It would be his desire, at some future time, to repeat these experiments with more elaborate apparatus, and (with the aid of experience already gained) complete the work.

The Jerzmanowski Process-Apparatus for Producing Gas.

On July 16th, U. S. Letters Patent (No. 542,855) were granted to Mr. E. J. Jerzmanowski, of this city, covering an improvement in process of and apparatus for the manufacture of gas. Using the words of the specification:

The invention relates to an improvement in the manufacture of hydrogen gas on what is set forth in the patent to C. M. Tessié du Motay, granted on the 29th day of June, 1880, No. 229,338. According to the process, which is fully detailed in said patent, steam, preferably superheated, carrying with it a certain amount of vapor of naphtha or its equivalent is converted in the presence of highly heated lime, producing substantially pure hydrogen, the carbonic acid being absorbed by cool lime. The cool lime is thereby converted into carbonate of lime, and such carbonate of lime is afterward reconverted into lime by highly heating it. In the patent above referred to the lime converters are shown as two inverted V-shaped retorts, and the gases are arranged to be thrown through said retorts alternately.

According to my improvement I prefer to separate my lime converters and to use one converter always to cause the reaction which produces the hydrogen and carbonic acid, and another independent chamber, or there may be two or more of them, to absorb the carbonic acid. The advantages of these two absorbing lime chambers will be hereinafter fully explained.

The invention will be readily understood from the accompanying drawings, in which Figure 1 represents an elevation partly in section, and Fig. 2 a plan view.

Only the lime converters and absorbers are shown, the process being fully explained in the Tessié du Motay patent hereinbefore referred to.

Similar letters refer to similar parts, and *A* represents a vertical lime chamber in which the primary conversion is to occur. *B B'* represent two absorbing lime chambers. These chambers are connected with the chamber *A* by the pipes *K C C'*, communicating with the chamber *A* by the opening *K'* at the bottom of said chamber. The chambers *B B'* connect with the hydraulic mains *L L'* and with the delivery pipe *M* leading to the holder. Valves *J J'* are provided in pipes *C C'*, and other suitable valves, as shown, are provided in the different pipes.

The chamber *A* is provided at its upper end with the pipes *D E*, through one of which combustible gas is introduced and through the other of which air is supplied to burn said heating gas. The chamber

Figure 1.

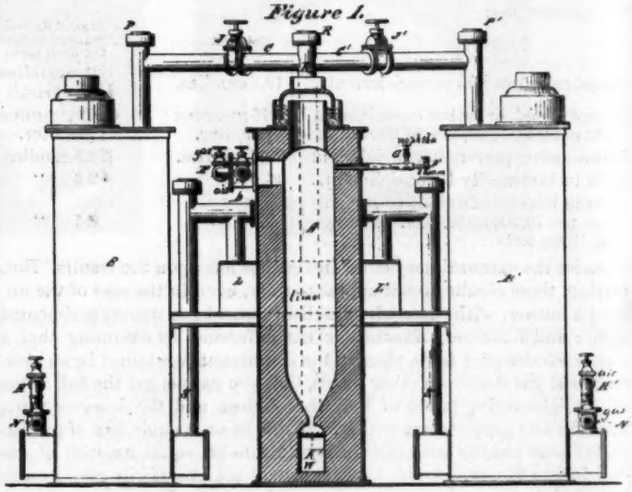
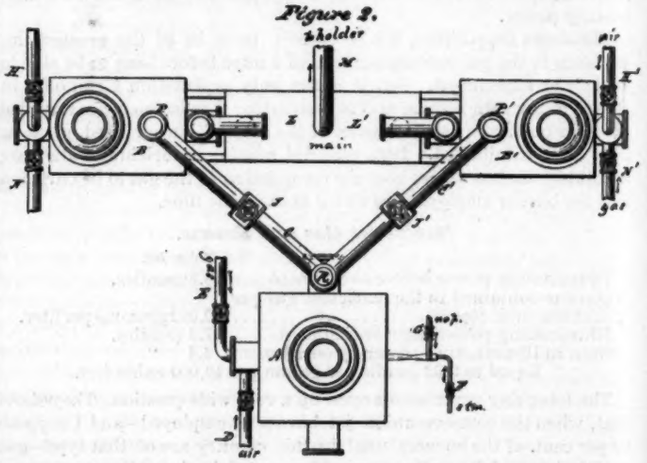


Figure 2.



A is also provided with the pipes *G* and *F*, through which naphtha and steam are injected. The steam pipe *F* may be used as an injector to spray the naphtha which enters through the pipe *G* into the converting chamber. These pipes *D E F G* are arranged at the upper part of the lime chamber *A*, as shown. The chambers *B B'* are likewise provided at their bottom with gas pipes *N N'* and air pipes *H H'*. The pipes *C C'* are provided with escape or purge valves *P P'*.

The operation of my apparatus can now be explained. It will be readily understood that it is desirable to have one body of lime at a high temperature and another body of lime at a low temperature, in order to carry out the process properly, and also that these two bodies of lime be continually in a condition to do their proper work in the process. Gas and air are first admitted to the chamber *A*, and, being consumed in said chamber, the products of combustion pass upward through pipes *K' K* and escape by the purge valve *P*. After the gas and air have been used to heat the lime in the chamber *A* the resulting products of combustion can be caused to flow through the chamber *B* or chamber *B'* for purposes to be explained. After the chamber *A* has

been sufficiently heated the purge valve *R* is closed and steam and naphtha are injected into the apparatus through pipes *F* and *G*, and a conversion occurs in the presence of hot lime into hydrogen and carbonic acid with some other impurities. The purge valve *R* being closed and the valve *J* opened the carbonic acid and hydrogen pass down and through the absorbing chamber *B*, and the carbonic acid is absorbed by the lime in said chamber, which is at a low temperature.. The free hydrogen then passes upward through pipe *S* and hydraulic main *L* to the main gas pipe *M*. The lime in the chamber *B* is by this process converted into carbonate of lime, and when it has absorbed all the carbonic acid which it can properly take the hydrogen and carbonic acid from the converting chamber *A* are caused to flow through the absorbing lime chamber *B'*. As soon as this is done air and combustible gas are allowed to flow into the absorbing chamber *B* by pipes *H* and *N*, and the purge valve *P* being opened the combustion in the chamber *B* drives off again the carbonic acid which escapes by the purge valve *P*, converting once more the carbonate of lime into lime. The lime in the chamber *B* being thus heated and the carbonic acid driven off, the valve in the gas pipe *N* may then be closed and air alone be allowed to flow through the chamber *B*. In this way the temperature therein may, if necessary, be reduced to a sufficiently low degree. The question as to whether such air is or is not to be used will be determined by the number of apparatuses employed and the time which is allowed the absorbing chambers to cool before they are put in requisition again.

It is obvious that by duplicating the chamber *A* a continuous process may be carried on, and one combustible gas supply or heating furnace may be used to heat both the converting chamber or chambers *A* and the absorbing chambers *B B'*. I prefer always, however, to have two absorbing chambers to one converting chamber; but a sufficient number of absorbing chambers should always be employed to receive and purify the hydrogen and carbonic acid produced in the converting chamber *A*. By arranging the pipes *D E F G* in the upper part of the converting chamber *A*, the dust and fine lime particles are driven down and may be removed from the dust chamber *W* by opening a suitable door.

I do not claim herein any matter set forth in the Letters Patent to Tessié du Motay, No. 229,338, which sets forth a process in which gases are thrown alternately into one or the other of two converters, my invention being distinguished from that of said Tessié du Motay by the fact that I employ one chamber always for conversion and the second chamber always for purification.

The inventor's claims are:

1. In an apparatus for producing hydrogen, a converter having feed and discharge pipes in combination with absorbers having discharge pipes, the independent connecting pipes between the converter and the said absorbers, provided with suitable valves, the steam and hydrocarbon supply pipes leading to the converter, means for heating the converter and means for heating the absorbers or purifiers, substantially as specified.

2. The herein described process of producing hydrogen, consisting of, first, charging a converter with calcareous material, next passing the products of combustion of combined gas and air through said calcareous material to heat the same, permitting the products of combustion to escape through a suitable valve, next bringing combined steam and naphtha or liquid hydrocarbon into conjunction with said heated calcareous material and passing the resultant gases to and through a body of cooler calcareous material in absorbers, to free the hydrogen contained in said gases from carbonic acid, next passing the free hydrogen from said absorber to a suitable receptacle, next bringing the calcareous material within the absorber to a state of incandescence to expel the carbonic acid, and finally bringing cold air into conjunction with said incandescent calcareous material to cool the same, substantially as described.

Selection of High-Speed Engines for Electric Lighting.

[By Mr. Fred. W. Richart, in *Electrical World*.]

Having settled the question of size, and whether the engine is to be simple or compound, condensing or non-condensing, then comes the matter of choosing from among the many different makes the one that will most satisfactorily meet the requirements of the situation as to economy of steam consumption, regulation, reliability, freedom from accidents and ease of repairs.

It is the purpose of this article to point out details of designs and construction that are desirable, and those to be avoided. It is hardly probable that any engine can be found on the market that shall embody all desirable features, and be free from all undesirable ones. Cases may arise where changes may be required of the builders, or the requirements may be such as to demand a distinct design.

The principal features affecting the economy of a steam engine are steam distribution, clearance, and radiation. The conditions for most economical steam distribution in an engine running at uniform speed with variable load are constant admission, release and compression, and variable cut-off. The majority of high-speed engines have but a single valve performing all the functions of admission, cut-off, release and compression. For the engine to be automatic, the cut-off must be variable, but with the single valve it is impossible to vary the cut-off without varying the other functions, while it is desirable that all others should be constant. This may be nearly attained by the use of two valves, one driven by a fixed eccentric and controlling release and compression, and the other driven by a shifting eccentric, and controlling admission and cut-off.

With the combined admission and cut-off valve, the admission may be nearly but not quite constant with variable cut-off. A four-valve engine will secure the best steam distribution, and tends to reduce clearance; but it makes the engine more complicated and adds very materially to the cost.

In ordinary lighting plants, and especially small ones where but one engine is used, and that runs on light load much of the time, it is hardly worth while to pay the extra investment for the more complicated machine, for the best of engines cannot be economical on very light load. However, high cost of fuel may in many instances make it more economical to buy the more costly engine. Where the duty required of an engine will keep it pretty uniformly loaded at or near its capacity, it is unquestionably better to have a better steam distribution than one valve can give. In such a case care must be exercised that the more complicated valve gear is not so defective in design or unmechanical in construction as to render it in any degree more unreliable than the simple gear. It is certain that much more attention is now being given to questions of economy by builders of high-speed engines than was formerly. This has been brought about largely in order to hold their own against the builders of Corliss engines, although the high-speed engine has much the advantage in point of space and ability to drive electrical machinery direct connected in small units.

The cylinders of compound engines should be so proportioned that the range of temperature is the same in each. By this means the amount of condensation and re-evaporation in either cylinder is not carried to excess.

In the majority of compound engines the valve of the low-pressure cylinder is driven by a fixed eccentric, which, however, may be adjusted to suit various conditions of load, but is fixed during any continuous run. Some builders make the cut-off automatic for both cylinders. Where the load is nearly uniform the first-mentioned is entirely satisfactory; but where the load varies much and is light much of the time, it will not pay to compound unless fuel is high, and then it should always be run condensing as well. It is the writer's opinion that an engine having the cut-off of both cylinders automatic, simple in construction, and driven by one shaft governor, might prove satisfactory even under quite variable loads. There are several such on the market. One thing must be carefully noted, and that is not to run a compound engine non-condensing on so light a load that the low pressure cylinder becomes a drag instead of doing its share of work.

The clearance in high-speed engines is very large when compared with slow and medium-speed engines. Engines may be found with a clearance of 12 or 14 per cent., but this is excessively large. This large clearance is due mainly to the large steam passages necessary for high-speed engines. In engines with passages short and direct the above figure will not be reached by several per cent., perhaps may be as small as one half. Small clearances are economical, but it must not be carried so far as to make the port so small as to withdraw the steam, or cause too much back pressure.

Radiation from the cylinder and steam chest should be reduced to the least possible amount by felt or some equally good non-conducting material, surrounded by a polished iron jacket or wood lagging. A jacket of Russian sheet iron makes about the neatest appearance, and is easily kept clean. Steam jacketing, while unquestionably preventing the radiation of heat from the cylinder wall, and may even add heat to it, is still a debated question among the best-informed engineers. It is probably of very doubtful utility in small units, and especially so in high speed engines. Moreover, such refinements are seldom faithfully carried out in practice by engineers in charge of the smaller sized plants.

The importance of close regulation cannot be overestimated, for satisfactory and efficient service depends much upon it. To be quick and

reliable in its action a governor should be simple in its construction. A multitude of working parts and joints is to be avoided. Some makes of engines are supplied with governors that, while otherwise good, are slow in action because of the excessive amount of friction to be overcome in adjusting itself to a new load. Such a governor cannot regulate closely, and is therefore very undesirable. The effective length of the weight arm of the governor should not be so short as to require excessive speed to bring it into action when starting up, nor should it be compelled to move through a very wide angle in order to govern the engine. All joints and journals in the governor should fit closely but work easily. Ball bearings or knife-edge bearings are better than bored and turned journals. Another thing about governors, they must be kept clean if they work well. A little stiffness, caused by grit, corrosion, being a little tight, and perhaps even stiff grease, will cause an engine to govern badly. A badly governing engine usually means "kicking" customers.

To be reliable—that is, to be able to do duty 365 days in the year, year in and year out—an engine must be substantial, correct in design, of first-class workmanship, and properly supplied with good lubricating devices. The most substantial engine is not necessarily the one with the most iron in it. The reciprocating parts must not be made so heavy that they are difficult to counterbalance. More iron in the bed than is really necessary is not so bad a fault. However, in any case it should be so distributed as to carry the stresses without distorting its shape. That is to say, the metal carrying the stresses between any two points should be in a straight line between those points, or, if not, must be made much heavier than would otherwise be necessary, and parts carrying transverse stresses must be so designed and supported that they will bear a 50 per cent. overload without showing any sign of bending. The vibration in high speed engines is so severe that every precaution must be taken that none of the parts can become loose or disjointed. Cheap construction is liable to cause these points to be overlooked, although they are of vastly greater importance than fine finish, which merely attracts the eye. The use of check nuts on bolts should be supplemented by a spring cotter, as the check nut is sometimes jarred loose, and then both nuts work off. Bad accidents have resulted from neglect of this little precaution. Many bolts, especially on smaller-sized engines, are apt to be too small, not to do their work, but are apt to be twisted in two by men of little judgment of what a bolt can stand. One half inch in diameter is small enough for any bolt that carries any responsibility with it.

It is very common practice to screw the piston rod into the crosshead and rely on a check nut to hold it in place, but such check nuts will come loose, and to prevent accident in such cases a set screw should be screwed into the crosshead and against the piston rod to prevent its turning. Better practice than this is to have a long thread in the crosshead, making one end as a split nut to be clamped together by a bolt or machine screw to keep the rod from turning. It is better practice to screw and rivet the rod to the piston than to rely on a nut to hold it.

The cylinder head should have two holes drilled and tapped in which to screw handles by which to remove the head. The holes should be tapped clear through, then by screwing the handles in against the cylinder the head may be removed without the use of a cold chisel. The use of machine screws for this purpose is objectionable as it involves the use of a wrench, and affords no convenient means of handling the head after it is loose.

The cylinder should always be provided with some means of releasing water that may happen to be in the steam pipe on starting up, or that may be carried over by priming. This is provided for in some engines by the ability of the valve to lift from its seat, but with the piston type of valve other means must be provided. This is usually accomplished by using a spring valve similar to a safety valve, or by using a thin cast iron renewable disc that will break before an injurious pressure is attained in the cylinder.

The question of whether the piston valve, the back-plate balanced valve, or the steam-balanced valve is the more desirable, is worthy of consideration, although if in competent hands they would probably give equally satisfactory service. The piston valve and some steam-balanced valves have the merit that there is no adjusting that can be done about them, and are therefore better fitted to put in the hands of incompetent men than are the back-plate balanced valves or the Giddings type of valve, which requires some attention to keep the balancing pressure nicely adjusted. Some piston valves have no means of adjustment, while others are provided with self-adjusting packing. In a few years the former get to leaking appreciably, while the latter will run for a much longer time before requiring any attention. A good form of construction is to have removable bushings in the steam chest. When worn, a new valve and new bushings are put in by a few minutes' work, small expense, and the yet greater consideration in this class of work, that no time is lost with the engine. The advantage of the Giddings valve is that there are but two flat surfaces, the valve seat and valve, to keep in order, while with the back-plate balanced valves there are four surfaces to keep in working condition. Flat valves properly cared for and kept nicely adjusted cannot be excelled for keeping steam tight for long lengths of time without repairs being necessary.

The old style connecting rod, tapering from the middle toward both ends, is not the best shape to resist the stresses to which it is subjected when running at high speeds. The best modern practice is to make the thickness uniform and tapering the width from the crank end toward the crosshead, or if it is desired to have the rod of lighter weight the metal is cut away to leave the cross section like an I-beam. Rods having a rectangular cross section are sometimes too thin, and will spring under load. It is well to watch this point. It makes but little difference whether the rod have strap, marine or solid ends, so they are well made. Straps should be held on by two bolts with check nuts and spring cotter, and the gib and key only used for adjusting the box. Keys should be long enough to reach clear through the strap when the box is new, have a small hole drilled through the end and a spring cotter put in to avoid all possibility of the key coming out should the set screw come loose. Sometimes a long counter-sink is milled in the side of the key to receive the set screw. Should the set screw jar loose the key can come out only so far as the counter-sink admits.

Some builders have good success with built-up crank shafts, but a solid forged shaft is certainly more desirable in a center crank engine. In a center crank engine the crank pin should be as large as the shaft, because if not it introduces a flexible place in the shaft, and may cause it to spring and run hot. For the reason that it does not affect the stiffness of the shaft of a side crank engine, it is not necessary that crank pin should be as large as in the former case. However, ample surface is always desirable, and it must not be made so small that the oil can be squeezed out in running. The main shaft of this class of engine should be much larger in size than is necessary in slow speed engines, that the bearings may have ample wearing surface without making them too long, and that it may not spring when running. The best grades of center crank engines have the shaft almost one-half the diameter of the cylinder in the smaller sizes, and reducing somewhat in the larger sizes. This proportion is for simple engines.

The flywheels should be thoroughly free from any flaws whatever. Possibly steel castings are much safer than cast iron, but it is very rarely that the flywheel of a high speed engine explodes. The wheel should be heavy, both for steadiness of speed and to make a substantial job, and should be accurately balanced. A truer running wheel will be obtained by having the hub split, bored to exact size and clamped to the shaft by bolts through the hub than by the usual method of keying.

The guides and crosshead should have ample wearing surface. Some builders make the length of the crosshead gib equal to the length of the stroke, and the width equal to one-half the cylinder diameter; while this gives a larger surface than is necessary it is not a bad fault. The gibs or shoes should be made of bronze or lined with babbit metal, and adjustment provided to take up the wear. Bored and V guides are objectionable on horizontal engines for the reason that the oil tends to flow to the center or edge. This objection does not hold in upright engines, and in some styles of self-oiling engines where the oil supply is so abundant that the slide is well lubricated no matter what the shape may be. The crosshead pin is sometimes flattened at the top and bottom so it will not wear out of round. Probably better practice is to make the pin removable and turn it around occasionally to distribute the wear over the whole surface.

The main bearings should be lined with the best quality of babbitt metal, as also the crank pin boxes. At the factory it is usually hammered in, bored and scraped to fit, but it is usually impracticable to hammer in and bore out a box where the engine is running, and the box should be so designed that this kind of repairing can be quickly and at the same time accurately done. Babbitt-lined boxes for the crank pin are preferable to brasses, because this part is most liable to run dry and heat, and in case it does the babbitt will melt out without damaging the crank pin, while the brass, requiring a higher temperature to melt it, may damage the pin considerably.

The methods of lubrication and the devices used deserve the closest study. Uncertain methods of lubrication may totally unfit an otherwise good engine for electric lighting purposes. An engine for this work must always be able to make continuous runs of from 12 to 20 hours daily, and sometimes they are required to run several weeks

without stopping. Every oil cup, receptacle or device should be so arranged that it may be filled while the engine is running. Where oil cups are used none but the very best should be allowed, and those should be large enough to hold sufficient oil for a considerable run. The cylinder lubricator is one of the most important, and should be easy to fill, have the upper connection 4 feet long to make the feed positive, and have the sight glass large, so the drops of oil cannot come in contact with and adhere to the sides. It is needless to say that the old-fashioned tallow cups are useless for this kind of work, being wasteful, and, worse than that, you don't know when they are working, or when empty. An oil pump should supplement the cylinder lubricator to use in starting up, and in case of emergency. The crank pin is more difficult to properly lubricate than any other part. Wipe oilers do very well as long as the boxes are nicely fitted, but, nevertheless, they require careful watching. In some engines, in addition to the wipe oiler, the waste oil from the main bearings is caught in a groove in the disk, and conveyed through holes to the crank pin. This is certainly a very great help. The enclosed types of self-oiling engines are usually very satisfactory, but in these some of the parts are a little more difficult to get at. There is also the satisfaction of knowing it can be left to itself for a considerable length of time if necessary.

Means of adjustment should be provided for all places where the wear demands it, but this is too frequently carried to excess, and in incompetent hands becomes a source of annoyance, because they can't stop tinkering till they get the machine out of adjustment.

The engine should be designed with a view to getting at any part without disturbing many other parts. Times do come when repairs must be made, and made quickly; and in such circumstances no one wants to spend unnecessary time in getting at the affected part.

A cast iron sub-base looks better than a cap stone, and especially so after it has become smeared with oil. Aside from this it has no particular advantage, except that it gives more weight to the engine proper. Most builders usually furnish them. In most cases their cost will be a little more than the cost of a cap stone.

The general appearance of an engine may be considered, but not till all questions of utility, economy and safety have been fully decided. Appearance is pleasing, but it does not pay dividends.

The Weber Gas Engine.

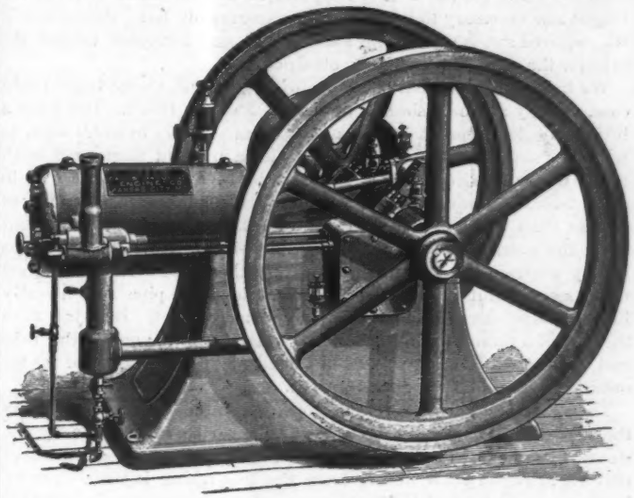
On the first outward stroke of the piston of the engine built by the Weber Gas and Gasoline Engine Company, of Kansas City, Mo., a mixture of air impregnated with the proper amount of gasoline or gas is drawn into the cylinder, passing through the valve chambers, as shown in the cut. On the in-stroke of the piston, the mixture in the cylinder is compressed into the space between the cylinder head and the piston. The combustible mixture is then ignited by a device consisting of a short iron tube closed at the outer end and connected to the interior of the cylinder. The tube is inclosed in a chimney and heated by a Bunsen burner. The air is expanded by the heat evolved and an impulse given to the piston.

When the piston has reached the second outstroke, the exhaust valve is opened and remains open during the second instroke of the piston, and the products of combustion are expelled through the exhaust pipe, which is conducted to the outer air.

The valves are all of the direct acting poppet valve type, requiring no cleaning or oiling, as they lift squarely from their seats and without friction. These valves are seated in separate castings so that renewal is possible when the seat is worn. They are so located as to render them easy of access for grinding. The valve chambers and valves are kept from becoming overheated by means of circulating water around their seats.

The valve gear and governor (which includes all working parts of the engine, excepting crank shaft, piston, etc.), are incased in an iron housing, dust and grit proof, and run constantly in oil, thereby insuring complete lubrication at all times. The crank shafts and nearly all the working parts are made of steel and finished to gauge. The cranks are not forged but are slotted out of solid steel and finished cold. The cross head and wrist bearings are of phosphor bronze. The wrist bearings are lined with nickel babbitt.

The flywheels of these engines are made with heavy rims and of light but very strong arms. They are exceedingly heavy, and by this is attained the necessary conservation of power, which causes the engines to run with regularity of speed. The governor is simple in design and sensitive to the slightest variation of speed. It gives the engine only gas at the proper time to do the work, consequently the amount of fuel used depends on the amount of work done. When only part work is done, only as many charges of gas are admitted and iguited as are needed to keep up the speed of the engine. When this speed is slightly exceeded, the governor does not give gas or air, and the engine works in a vacuum; but when the engine is worked up to its full capacity the governor gives a charge at each stroke. A steady motion under part or full load is obtained by the momentum of the two heavy flywheels.



An important feature in the construction of engines of this type consists in keeping every part of the engine from becoming overheated. In these engines water is circulated entirely around the valve chambers and entirely across the cylinder head. This circulation of water is not to keep the engine cool, but is to keep the engine from becoming overheated, so that it may be properly lubricated.

The water tank varies with the size of the engines and holds sufficient water to keep the engine at the proper temperature. The heat of the cylinder causes the water to circulate, the heated water going to the top of the tank and the cold water entering the cylinder from the bottom of the tank. The same water is used continuously, there being a slight loss from evaporation.

The pistons are of an unusual length, which gives large wearing surface and adds to the life of the engine. The rings are made up in sections, with a German silver spring behind each section, forcing the rings out to the walls of the cylinder at all times, taking up the wear, however slight. By this means the rings can be used indefinitely, or until they are worn out entirely. The gasoline is used in its natural state, with no intermediate gas making machinery or appliances. The gasoline is kept in a galvanized iron tank, which is usually placed outside the building and connection made from tank direct to the engine by ¼-inch or ⅜-inch iron pipe. Should the engine accidentally become stopped, no matter from what cause, and the valves be left open, not a particle of gasoline or gas would escape, owing to the peculiar construction of the fuel inlet. These engines are built in sizes from 2 to 100-horse power.

Hints About Injectors for the Engineer and the Fireman.

The *Tradesman* says that when putting up pipes for injector work it will be a good rule to follow to always put valves on so that the pressure will always tend to open them—in other words, so that the pressure comes underneath the disk. This will in a great measure prevent the disks from coming off the stem, and if they do become loose the pressure always opens them when the stem is unscrewed. Many object to this mode of piping, as the strain all comes on the screw threads to resist the steam pressure, and if the threads give way the valve flies open. The cases of threads giving way are very rare indeed, and if a valve is used until its threads are worn so as not to half fit, the user will be responsible if they do give away. On the other hand, the steam coming under the seat always overcomes the slack in the loose disk and makes it much better to start the injector and to regulate the water or steam supply when the latter is necessary. And still further, with steam under the seat we can pack the valve stem with steam on, while with valves piped the other way this cannot be done with any comfort, if at all. This applies to water valves just as much, except in the matter of packing. In the gate valve this does not apply, although for

small valves the gate valve is hardly recommended as necessary or desirable. As in the case of pumps, the pipes must be ample in size, especially if long (if over 10 feet long make one size larger for each 10 feet) and sharp bends must be avoided and made as small in number as possible.

Where I have said one size larger for each 10 feet do not think it is meant to use a half-inch pipe for the first 10 feet from the injector, then a three-quarter for the next 10 feet, and so on, but make it all of the largest size necessary to use, although experiments have shown that if the required size is used at the water supply and increased toward the injector the same results will be obtained.

We have hardly spoken of lifting injectors as yet, except in the yacht case, and my advice is similar to that of *Punch:* Don't. Don't use a lifting injector where it can be avoided, particularly in small sizes, as while the makers will claim perfect satisfaction, and many will work nicely under good conditions, they are to be avoided if you wish to avoid trouble some of these days. They are much more susceptible of disease than the non-lifter, because of inherent weakness dependent upon the outside conditions, piping and similar troubles. It seems hardly necessary to say that lifting is rather a misleading term, yet many seem to think that the steam chases down the pipe and literally lifts the water out of the well below by actual contact. It is just as in the case of a pump, the air above the water is drawn out of the tube and the water follows it, pressed or forced up by the pressure of the air outside the pipe on the surface of the water.

The steam jet blowing across the opening in the tube sucks or draws the air with it, and finally the water comes, to be acted upon by the steam the same as in the case of the non-lifting injector. So remember that the lifting injector differs from the non-lifting injector only by having a steam jet which lifts (if we so call it) the water to be acted on by the injector proper—in other words, the lifting attachment is simply added to the non-lifter to get the water in position for the injector to act on it. Sometimes this attachment is separate, and more often made a part of the injector itself, by introducing an additional jet, which does the lifting.

In piping lifting injectors great care must be taken to have the suction or supply pipe perfectly air tight if you want good results. For the admission of air is practically certain to give trouble unless the injector is large and the quantity of air admitted very small. In certain injectors, called automatics by their makers, this is not so detrimental, from the fact that they are so arranged that the two jets work at all times, and whenever the water supply is shut off they simply blow steam until the supply is opened, when the lifting jet brings the water and the forcing jet takes it into the boiler. These injectors are not to be recommended as perfectly satisfactory for all cases or for any regular work, excepting on such boilers as traction engines, yachts, etc., where the water supply may be momentarily shut off by the swinging of the tank and the supply pipe come out of the water. They are not as efficient as the plain injector and much more liable to give trouble, as many users know to their sorrow. It will be seen from this that the first place to look for trouble in the lifting injector is the supply pipe, a leak being the first thing to be looked for. This can generally be detected after a little experience by the appearance of the overflow in starting. If the injector starts and breaks immediately and in breaking shows a broken column of water before the steam shows, as if the water was filled with air, we may look for a slight leak, but if the injector almost starts and seems to catch the water in pieces and then lose it, a larger leak is to be looked for. When the injector simply refuses to take water at all and you can hear it drawing air, the leak has assumed large proportions and can be easily found no doubt. If the suction or supply pipe is where you can get at it, you can detect the leaks generally by taking a candle or a torch and holding it at each joint, while the steam is turned as though trying to work the injector, the air that is drawn in will show where the leak is by drawing the flame of the candle with it. In case of very small leaks that cannot be seen in this way, or when you cannot get at the joints with a torch, just turn the steam into the discharge pipe and watch the joints, and if there is a leak you can detect the escaping steam, which will show you where the piping needs attention.

When we consider the importance of having a tight supply pipe, particularly in lifting injectors, it will be seen that it does not pay to use old pipe for this, as it may spring a leak at times when you need the injector badly. And where the supply pipe is very hard to get at this is all the more important.

As in many other places around a steam plant, it pays to spend a few dollars in order to have things as secure as possible against breakdown, and particularly where your whole plant depends on the boiler being continuously supplied with water, yet many will neglect these precautions and then blame the injector for failing to work.

Transmission of Heat Through Boiler Plates.

Engineering Record remarks that the rate of transfer of heat through the heating surfaces of steam boilers is a disputed question, inasmuch as it is maintained by some that it is proportional to the difference between the temperature of the heated gases and that of the water, while others hold that it varies as the square of the difference; hence, if the latter holds true a boiler will not only evaporate more water as the temperature of the gases is raised, but the evaporation will be increased in a greater proportion than the increase in the difference of temperatures. Professor Rankine, on page 258 of the "Steam Engine," makes the statement that rate of transmission varies directly as the difference between the temperatures of the two fluids. This may be expressed by the formula

$$Q = K\frac{T-t}{X} \qquad (1)$$

in which

Q = units of heat transmitted per hour by 1 square foot of heating surface.

K = an empirical constant depending upon the material of the boiler plate and its condition.

X = the thickness of plate in inches.

T = temperature of the hot gas.

t = temperature of the water.

Professor Rankine, on page 258 of the "Steam Engine," makes the statement that "the rate of conduction through a flat layer of uniform thickness is simply proportional directly to the difference between the temperatures of the two faces of the layer and inversely to its thickness." *Engineering* in an interesting article discusses the question and continues in part as follows: Rankine, says our contemporary, was only speaking of what takes place in the substance of a homogeneous plate the two faces of which are maintained at known temperatures, whereas in boiler work the only temperatures dealt with are those of the water and gas respectively. If the wet and dry surfaces of the plate are sensibly of the same temperature as the fluids with which they are in contact, then it might be assumed that the rate of transfer would vary as the difference in temperature.

Mr. Durston, however, has shown that in the case of some tube plates with which he experimented, the dry side was hotter than the water by not more than about 67° to 86°, when the plates were clean. When the wet side had a deposit upon it of earthy grease about one-sixteenth of an inch thick, the temperature of the dry side of the plate rose to about 537° above that of the water, but was still far below that of the gas. No experiments seem to have been recorded in which the temperature of the wet side of the plate was determined. It seems probable that when the plate is quite clean it is not much hotter than the water, although there must be some difference, or there could be no transfer of heat.

When very dirty, Mr. Durston's experiments show that the temperature of the wet side may be considerably higher.

The principal cause, besides soot, of the great difference found in practice between the temperature of the furnace gas and that of the dry side of the plate, is probably the fact that as soon as the layer of gas next the plate has given up part of its heat it forms a badly conducting screen, which prevents the rest of the hot gas touching the plate till it has moved out of the way by convection or otherwise.

Heuman showed, in 1876, that till a plate was raised to a certain critical temperature flame could not come in contact with it, and Mr. Thomas Fletcher, of Warrington, demonstrated this fact very clearly in a lecture[1] delivered in 1886. The varying resistance due to this layer of comparatively cool gas, and possibly other causes, renders the statement quoted above from Rankine, and equation (1), inapplicable to boiler problems.

Rankine himself, continues our contemporary, fully recognized this, and on page 260 of the "Steam Engine," gave the formula

$$Q = \frac{(T-t)^2}{a} \qquad (2)$$

in which t, T and Q have the same values as before. The thickness is not here taken into account at all, as the substance of the plate offers such a small proportion of the total resistance that it is negligible.

In some experiments by Mr. Blechynden, which fully corroborated this formula, he found the influence of thickness on the rate of heat transmission was small with perfectly clean plates, while it was practically *nil* when the plates were at all dirty.

1. See JOURNAL, July 16, 1886, p. 40.

In this formula a is an empirical factor which Rankine found to vary in actual boilers between 160 and 200. Mr. Stromeyer considers it should be 217. Mr. Blechynden's experiments gave a value of about 40 to 50 for clean plates varying in thickness from $\frac{1}{2}$ inch to $\frac{1}{4}$ inch. As this corresponds to an efficiency four times greater than Rankine and others have found in actual boilers, some explanation seems necessary before such a low value of a can be accepted. His results, however, plot so well that they may be taken as evidence of the truth that the rate of transmission varies as the square of the difference of temperature; or in other words, that the rate of transmission per degree of difference is simply proportioned directly to the difference between the temperatures of the water and the furnace gas.

Mr. Blechynden points out that the fact that the efficiency of heating surface varies as the square of the difference of temperatures shows the importance of making this difference as large as possible by means of rapid combustion, obtained by fan blast or high chimneys.

A comparison of equations (1) and (2) shows that the difference of the temperatures of the two faces of the plate must vary nearly as the squares of the temperature differences of the gas and the water, and although Mr. Durston's experiments do not give sufficient data to establish this, such as bear upon it agree with this conclusion as nearly as could be expected in experiments of this nature.

Mr. Fletcher in his lecture described the increased efficiency he had found with internally ribbed flues. This was ascribed to the fact that as the conducting section of the ribs was small in comparison to their heat absorbing surface, they soon reached the critical temperature at which flame contact was possible.

Mr. Fletcher exhibited two vessels, one with a plain bottom, the other with studs projecting from its under surface. Although the surface of the latter in contact with the water was stated to be only half that of the plain vessel, it boiled a gallon of water in little more than half the time required by the plain vessel, so that the studded surface was over three times as efficient as the plain surface, a result apparently entirely due to flame contact. As already pointed out, the results of experiments seem to indicate that the metal, unless very dirty, readily parts with its heat to the water, so that the ribs outside the tubes would not be likely to greatly increase their efficiency.

Mr. Fletcher boiled water in a vessel placed over a powerful gas burner of the Bunsen type, and showed that a piece of paper which would char if raised to a temperature of 400° F., was not discolored when pasted under the bottom of the vessel used as a boiler. When the eye was placed on a level with the bottom of the vessel a clear space was seen between it and the flame. The thickness of this space exceeded that of the paper by about one-fortieth of an inch. This was demonstrated by laying thin pieces of copper against the paper. If these were under one-fortieth inch thick the paper was not charred; if the copper was thicker than this the paper was at once discolored.

The Coal Fields of Alabama.

Mr. E. M. Parker, in his report on the coal fields of the United States, has this to say about the Alabama mines, the product from which is attracting more and more attention as the seams are being developed and as the excellent qualities of the coal are being the better appreciated:

The Alabama coal fields are divided into three regions named from the rivers which drain them, the Cahaba, the Coosa and the Warrior. The Warrior region is by far the longest, containing 7,810 of the 8,660 square miles underlaid by coal measures. Included in this is the Lookout Mountain region, which runs a narrow belt from the Georgia line parallel to the Warrior field proper, and separated from it by a valley drained by branches of the Coosa river at its southern end and of the Tennessee river at the north.

The Cahaba and Coosa fields, containing 435 and 415 miles, respectively, extend in nearly parallel, narrow belts along the southeastern border of the Warrior, and are separated from it by the valley in which the city of Birmingham is located, and from each other by the valley of the Cahaba river. Because of the demand created by the war, coal was mined in Alabama during its existence; but the first product of which there is any record from the Alabama fields was obtained in 1870, when 13,200 tons were mined. In 1882, the first year covered by the first volume of Mineral Resources, the output was 896,000 short tons. The maximum product in any one year was in 1892, when it reached the remarkable total of 5,529,312 tons, an increase in 11 years of 4,633,312, or 5,171 per cent. The output in 1892 was more than 60 times that of 1882. In 1894 the product had fallen, as a result of hard times and the great strike, to 4,397,178 tons, but even this shows an output nearly 50 times that of 1882.

The improvements on the Warrior river, conducted by the United States Government, and consisting of a series of dams for slack water navigation, are expected to do much toward extending the use of Alabama coal. One of the dams (of which there are to be five) is finished, and two more are nearing completion, and it is expected that they will be ready for use by September 1. When this means of transportation has been accomplished it is claimed that coal can be freighted from the Warrior field to Mobile for 50 cents per ton. It is stated that similar improvements will be made on the Coosa river, which will afford water transportation to the Coosa fields.

In 1893 the amount of coal produced in Alabama was 5,136,935 short tons, having a spot value of $5,096,792. The output in 1894, therefore, shows a decrease of 739,757 short tons, or 14.4 per cent. In value the decrease was nearly 20 per cent. (19.85, to be exact), or $1,011,257. The decrease in product was due to the general strike inaugurated by the United Mine Workers, in April, and which continued in force until July, in some cases, and in others was prolonged until August. The scarcity of coal occasioned by the strike had the effect for awhile of advancing the market price, but this was not sufficient to offset the prevalent decline in values, and an average reduction in price of 6 cents per ton, or from 99 cents in 1893 to 93 cents in 1894 is shown.

Decreased production is observed in all of the three principal counties, Bibb, Jefferson and Walker. In Bibb county the decrease was over 50 per cent.; from 806,214 tons in 1893, to 401,061 tons in 1894. The decrease in Jefferson county exceeded 300,000 tons. In Walker county the decrease was comparatively small, being 35,396 tons from a total production in 1893 of 927,349 tons. The following table gives the product by counties during the past year:

Coal Product of Alabama in 1894.

Counties.	Loaded at Mines for Shipment. Short Tons.	Sold to Local Trade and Used by Employees. Short Tons.	Used at Mines for Steam and Heat. Short Tons.	Made into Coke. Short Tons.	Total Production. Short Tons.
Bibb.....	379,488	4,250	15,190	2,133	401,061
Blount.....	....	6,000	....	2,000	8,000
Jackson	....	6,011	....	....	6,011
Jefferson.....	1,805,269	11,744	82,959	866,330	2,766,302
St. Clair	34,167	950	5,200	3,200	43,517
Shelby.....	72,904	350	3,365	....	76,619
Tuscaloosa....	129,999	1,400	6,720	52,962	191,081
Walker	843,227	5,066	16,970	26,690	891,953
Winston.....	4,491	140	....	...	4,634
Small mines..	....	8,000	....	....	8,000
Total....	3,269,548	43,911	130,404	953,315	4,397,178

State Mine Inspector J. D. Hillhouse has about completed his report of the production of coal in Alabama for the first six months of 1895. It shows a larger increase as compared with the same period of 1894, and if the present rate is kept up during the balance of the year the total output for the year will be the largest in the history of the State. If the output at the mines which have so far reported is maintained during the remainder of the year the total for 1895 will be 4,500,010 tons, or 64,320 less than 1893, and 627,928 tons more than in 1894. Some of the mines yet to hear from are among the largest in the State, and it is expected that their reports will show a large increase in the production of coal for any previous year. In addition to these mines there are a number of others that have just recently been opened, and still others to be opened in the next few weeks.

Hydraulic Power for Digging Foundations.

The method employed for sinking the foundations of the Johnston office building now in course of erection in this city, at the corner of Broad street and Exchange place, New York, is peculiarly interesting by reason of its novelty and the rapidity with which the work was done. Where the building stands bed rock was found only 42 feet below the sidewalk, and it was decided to sink the foundations by a scheme devised by the general manager of the Hydraulic Construction Company, who secured the contract for the work. The operations consisted in sinking a series of 44 steel cylinders, varying from 6 to 13 feet in diameter, according to the load each was to bear. These cylinders were not designed to bear any weight, but to act merely as a shield within which, after they were sunk, men could work and build up the piers to carry the superstructure. In sinking the cylinders each had around the lower inner edge hollow iron castings in the shape of a segment of a circle, and about 2 feet in length. These were sharp on

the lower edge, but irregular in outline and pierced with about 100 small holes. To the center of each of these hollow castings was attached a 1¼-inch iron pipe running to the top of the cylinder, where it bent over the outside edge and connected with a hose coupling. A cylinder being placed at the point where a pier was to be erected, the water was forced down through the little openings in the iron castings by means of a powerful pump. This loosened the earth at the lower rim of the cylinder so that its weight gradually forced it down; but in order to hasten the sinking through the earth as fast as the water jets softened a place for it, many tons of pig iron were piled on top of the cylinder. While the work of sinking a cylinder was going on a man constantly tested it to see that it went down straight. Two other men were in charge of the lever gates controlling the streams of water which were doing the digging. Whenever one side descended faster than another, some of the streams would be shut off and others opened, the effect of which was to dig a little more in one spot than another under the edge of the cylinder and thus bring it back to the level. Sometimes in the sinking process large rocks were encountered, and in one case an old pile was struck. In the latter instance it was necessary to stop work, dig out the dirt from within the cylinder and cut away the pile. This course, however, was not necessary where rocks were encountered. One of the water-spouting castings was attached to a separate pipe and sunk beside the rock either inside or outside of the cylinder, when the water jets would soften a place for it and the pressure of the cylinder thrust the stone aside into the new place provided for it. After the earth was removed from the cylinders each one was filled with solid concrete and brickwork, and over this was laid a double grilling of steel beams, on which were placed the cast iron caps to support the columns of the building. On the south side of the site, where the wall rises next to the adjoining building, the structure will be carried by a series of eight large cantilever girders resting on a double line of cylinders.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. A. B. Eilbeck, formerly with the New York and East River Gas Company, of this city, has been appointed General Manager of the Welsbach Commercial Company, with headquarters in the Drexel Building, Philadelphia.

The Knoxville (Tenn.) Gas Light Company offered to light the streets of that city by means of the Welsbach burners, on the basis of a payment of $15 per lamp per annum, the lighting schedule calling for an all night and an every night service. The bid also provided for lighting, extinguishing, cleaning and repairing. The authorities rejected the proposal on the ground that the charge was too high; wherefore it looks that the authorities of Knoxville are built on most economical lines, for it seems to us that under the Company's proposition Knoxville would have the satisfaction of being about as cheaply served in that respect as any other city in the States. Indeed, Mr. Young must have had considerable belief in himself and his Company to make such an extremely low bid.

A correspondent forwards the following: "Previous to 1865, the city of Washington Court House, Ohio, had only the most primitive methods for lighting the streets and business houses and residences; but in the spring of that year the Washington Gas Light Company was formed, and through the vim and persistent efforts of its projectors, the work on the gas plant was completed, the pipe system was finished, and the Company was furnishing gas to consumers before the close of 1865. This was quick and efficient work, and although it was appreciated by progressive people, the gas rate was so high ($10 per 1,000 cubic feet) that many were unable to avail themselves of the service. The price, however, was reduced from time to time, as the business would permit, until 1887, when the present management took charge. About the first thing the new management did was to cut the rates to $2, $2.25 and $2.50 per 1,000 cubic feet, and since then the price has been reduced on three different occasions, the ruling rates being $1, $1.25 and $1.50 per 1,000. The present officials are: President and Treasurer, Jerome Penn; Secretary, G. N. Clapp; Chief Engineer, George Swap; Electrician, Joseph Gillespie—all worthy and efficient men. Since Mr. Penn took charge of the business, as President, in 1887, all the old buildings have been replaced by new ones, in which new and improved machinery has been installed, and a gasholder of sufficient capacity for the output was constructed. During the period when the city was grading and otherwise improving the streets, the Company relaid its mains, larger diameters being substituted in many instances. The expenditure on this entire account was not less than $60,000, and the plant is complete in all respects. In the summer of 1889 the clamor for electric light induced the Company to add an electric annex, and the Company now has an electric lighting plant up to the supply of 100 arc and 800 incandescent lamps. In conclusion, it might be worth while noting that the Company's gas output is over double that reported for 1888."

The Directors in the combination concern at Newburgh, N.Y., which is known by the title, "Consolidated Gas, Electric Light, Heat and Power Company," are Messrs. B. B. Odell, Jr., J. V. Jordan, Samuel L. Carlisle, Alfred Bridgeman, Jos. A. Sneed, C. L. Waring, James T. Lawson, Thomas W. Gavey and C. T. Goodrich. The executive officers are: President, B. B. Odell, Jr.; Vice-President, Jas. T. Lawson; Secretary, C. L. Waring; Treasurer, C. T. Goodrich. The offices of the Company are in No. 14 Water street, Newburgh.

"Observer," under date of August 9th, writes: "I notice in your issue of July 29th that you speak of the appointment of Mr. A. F. Kelly to the Superintendency of the municipal gas works, Hamilton, Ohio, and although the error is a trifling one, perhaps you will not object to correcting it. The gentleman who takes charge, on the 15th inst., of the plant in question, is Mr. Henry H. Kelley, who has for the past five years acted as Assistant Superintendent of the Waltham (Mass.) Gas Light Company. The only reason Mr. Kelley goes to Hamilton and leaves Waltham is the financial consideration involved; and I am sure I write down only the simple truth when I say that the Waltham Company regrets very much the loss of his services, and joins with those of us in the East who know the genial and capable gentleman in the wish that his success in the West will be of the fullest measure.—Observer."

Attention is called to the advertisement, in our current "Want Column," of the Jowitt Carbonized Felt Company, of this city, which concern is desirous of purchasing large or small lots of coal gas tar. The advertisers can be looked upon as perfectly reliable, and will fulfil any contract they enter into.

The Board of Trustees of Bennington, Vt., have granted to the United Gas Improvement Company the right to manufacture and distribute gas in that district.

At the annual meeting of the Ipswich (Mass.) Gas Light Company the shareholders were most agreeably surprised by the declaration of a 2 per cent. dividend, the first return on the stock since the organization of the Company about 16 years ago. An oil air gas is sent out. The officers chosen were: Directors, Joseph Ross, T. F. Cogswell, C. W. Brown, J. A. Blake and George E. Farley; President, Joseph Ross; Clerk and Treasurer, George E. Farley; Manager, C. W. Brown.

The following ordinance, introduced by Mr. Maille, at a recent session of the New Orleans (La.) City Council, explains itself:

Section 1. That the City Comptroller be and is hereby directed to advertise in the official journal for 15 days for sealed proposals for the sale of the sole and exclusive right and privilege of furnishing gas lights for a period of 50 years, from April 16, 1897, in that portion of the city of New Orleans formerly known as Jefferson City, being as formerly described from "the upper line of the city of New Orleans to the upper line of Carrollton."

Sec. 2. The contractor shall have the right to dig up any and all streets, sidewalks, alleys and public places for the purpose of laying all necessary mains and service pipes in said former Jefferson City, and shall bind himself to place such streets, sidewalks, alleys and public places in as good condition as found previous to laying such mains and pipes.

Sec. 3. That the contractor shall have the sole and exclusive right of making and vending gas lights in said Jefferson City to such persons, firms or corporations who may voluntarily choose to contract for the same; provided that said contractor shall never charge the city of New Orleans any more than $50 per lamp post per annum, when lit; and shall make the proper deductions when not lit, should the city of New Orleans ever choose or decide to contract for such lights with said contractor.

Sec. 4. That inasmuch as the charter of the Jefferson City Gas Light Company (Act 96, 1869), does not expire until April 15, 1897, the said contractor, under this franchise, shall not begin the business of making and selling gas lights in said portion of this city called the City of Jefferson until April 16, 1897; but considering the trouble and expense of erecting a new plant, laying new mains and pipes, the said contractor shall be and he is hereby authorized to begin such preparatory operations or works as may be necessary immediately after the signing of

this contract, so as to enable him to be in a position to make, deliver and sell gas lights on and after April 16, 1897.

Sec. 5. That the qualifications for bidding on this franchise shall be a cash deposit of $1,000 in the hands of the City Treasurer, to be shown by a receipt to that effect, which $1,000 shall be immediately returned to all unsuccessful bidders. Said deposit of $1,000 shall be to guarantee the signing of the contract within 90 days of the adjudication and of its acceptance by the City Council; on default of which signing within said period, said $1,000 shall be forfeited.

Sec. 6. The contractor shall furnish a good and solvent bond of $5,000 in favor of the city of New Orleans conditioned for the faithful performance of the contract, and to act as a further security that the streets, sidewalks, alleys and public places shall at all times be replaced in as good condition as they were before digging up. Bidders shall disclose the names, places of business and residences of their respective sureties at the time of sending in their bids. The sureties on said bond, when accepted by the City Council, shall make oath of their solvency and legal capacity to sign said bond; and said oath shall be made part of the contract.

Sec. 7. That the successful bidder shall have the right to assign this contract or franchise to any person, firm or corporation competent to put the same into practical operation.

Sec. 8. That any person, firm or corporation convicted of wilfully altering or of wilfully causing anyone to alter the mains, pipes or works of said contractor without his consent in writing; or who shall in any manner draw gas illicitly from the mains, pipes, or works of said contractor, shall be fined from $5 to $25, or from five to thirty days' imprisonment, or both fine and imprisonment, at the discretion of the court having jurisdiction; and such person, firm or corporation shall be civilly responsible also for all gas so illicitly consumed, and for all such other damages as the contractor may sustain.

MR. B. E. LETANG, of the Jackson (Cal.) Gas Company, expects to have the electric lighting annex to that plant in full operation by December 1st.

THE Concord (N. H.) Light and Power Company is extending its distributing lines. This mention impels us to say that so far this year we have reports showing the placing of a total of 2,096 miles of additional main pipe, the average diameter of the lot being virtually 4 inches. Only 12 places report the laying of anything under 3 inches in diameter; the maximum diameter was 36 inches, of which about ⅝ mile was laid.

ACCORDING to the report of Mr. C. E. Newman, official gas inspector for San Francisco, Cal., the number of public gas lamps in use in that city, June 30, 1895, was 5,519. The San Francisco Gas Light Company has the contract for supplying the gas used in them, and the rate of payment for the service is 12 cents per lamp per night. The total money paid during the year on account of lighting the streets and public buildings with gas was $237,403.66, of which sum the San Francisco Gas Light Company took $214,778.73, the Pacific Gas Improvement Company receiving the balance, or $22,624.93. The public lamp gas lighting cost $206,210.52, and the gas lighting charge to public buildings cost $31,193.16. Inspector Newman's report is very complete.

THE Morristown (Tenn.) Electric Light Company's plant was sold under foreclosure proceedings. It was bought in by the General Electric concern for $4,000, which parent body held the mortgage that was in default. What a choice collection of wrecks the General Electric is storing up on its dry docks!

MESSRS. J. S. Hayes and Robert Peebles have secured control of the artificial lighting business of New Castle, Pa., and will operate the same hereafter. The New Castle Electric Light and Power Company, the Lawrence Gas Company, of New Castle, and the New Castle Incandescent Electric Light Company are the concerns which form the combination.

THE proprietors of the Davenport (Iowa) Gas Light Company recently issued the following circular to the gas consumers of that city:

"Now that the City Council has taken up the price of gas to the citizens, this Company has offered every facility in its power to enable the Council to become intelligent on this subject; inviting an investigation of the Company's books, or by the appointment of gas experts, thus to prevent the passage of an ordinance which, to work under, would amount to the confiscation of our bond and stockholders' property. We now propose to make the following prices, provided the city causes no litigation, on this question, to take effect on August bills: Illuminating gas, $2 per 1,000; discount, 25 cents; or $1.75 net; 20,000 cubic feet and over per month, $2 per 1,000; discount, 50 cents, or $1.50 net; fuel gas, $2 per 1,000; discount, 75 cents, or $1.25 net. Minimum meter rate, 25 cents per month on three lights. To residence consumers, using gas for illuminating and cooking, $2 per 1,000; discount, 75 cents per 1,000, or $1.25 net, with a minimum consumption of 2,000 cubic feet per month. Discount allowed on all bills paid on or before the 10th of the month. We beg to say to our consumers that the price of gas depends upon the amount of sales. We hope you will appreciate the cut in price and be more liberal with the use of gas, especially for cooking, as you will find it as cheap as any other fuel in this market."

THE following rules for gas piping, etc., have been formulated by the Passadena (Cal.) Gas and Electric Light Company, and the Company's Inspector has been instructed to observe them closely:

Size.	Greatest Length.	Greatest No. Burners.
⅜-inch, vertical only.....	15 feet.	2
½ "	25 "	5
¾ "	50 "	15
1 "	75 "	30
1¼ "	100 "	60
1½ "	150 "	100
2 "	200 "	200

The number of lights allowed per ⅜-inch opening is two, using the ordinary gas burner, and no ⅜-inch pipe must be run horizontally. No gas pipe of less than ½ inch should be used in piping buildings. No riser should be less than ½ inch and end of same must be located by the inspector. Openings intended for meter connections must be conveniently located and under direction of inspector, as meters will only be set in approved places. All drops must be placed plumb and well secured by straps soldered to the pipes and screwed to the joist, or drops may be soldered in if preferred. Bracket openings must also be so secured and run square with finish. Bends in pipe must not be used for any purpose. The size of drops should be ½ inch, and they should extend through the plaster about 1½ inches and all be alike in length. Bracket openings should extend through plaster about 1 inch, and all openings must be closed with iron caps. For hotels, churches, theaters or public buildings where a large amount of gas is to be used, the pipe must be of increased size, and plans of same should be submitted to the inspector before commencement of work. In making alterations or extensions in a building, or in piping an old building, the same regulations should be observed as in new work. All pipe between the meter and gas main will be run by this Company only, and fitters must not disconnect nor interfere with any of the Company's meters. On the back of this circular the gasfitter should make all plans of work, with length and sizes marked with figures, and submit same to the inspector before testing is requested. No concealed work will be inspected, and due notice must be given of time inspection is desired. No charge is made for such inspection, and information and suggestions will at all times be cheerfully given; but unnecessary visits must not be requested except at the expense of party doing the work. All pipe must be run in a good and workmanlike manner, be well secured and grade towards the meter. There must be no "traps" nor stoppages of any kind. Unions should not be used in concealed work. Split or broken pipes, or fittings repaired with cement or lead, or "rusted" to stop leaks, will not be passed by the inspector, and no work or alteration should be made to piping after inspection without due notice and reinspection. All testing will be done at a pressure of 10 pounds per square inch. In making joints the lead should be put on the male end of pipes and fittings and not in the fittings, as lead so placed will be pushed forward by the pipe with liability of closing same and causing stoppages. It is the intention of the Company to adhere to the above rules and no certificate of inspection will be given when they are not complied with. Parties interested are requested to allow no bill for gasfitting, unless accompanied by a certificate of inspection, which is an evidence that the work has been properly done. Particular attention should be paid to piping houses for gas for fuel, as it is rapidly taking the place of other fuels, and the work is best and cheapest done in the original construction of the buildings. At all fireplaces the pipe should be run to right hand side of same, about 2 inches clear of finish and 4 inches above the floor, and the same in relation to position of flue pipes in rooms without fireplaces, keeping about 15 inches to right of flue. In rooms having neither fireplaces nor flues an opening for gas stove should be conveniently placed and about 6 inches above floor. These openings should be ½ inch, and pipe to supply same run from nearest direct feeding pipe. In kitchens pipe should be properly placed for gas cooking stove and should usually be ¾ inch. All additional or detailed information will be gladly furnished without charge.

THE AMERICAN GAS LIGHT JOURNAL

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PROPRIETORS.

EDITOR—Jos. R. Thomas, C.E.
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AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—B. Westermann & Co., of New York.

MONDAY, AUGUST 19, 1895.

The Market for Gas Securities.

Consolidated showed no change since time of last writing, the opening to-day (Friday) being reported at 142 to 143½. Trading was dull and listless, and the general market was so ragged that even the roomiest professional traders were inclined to stand by and await the course of events. Consolidated is a decided purchase at anything under 145, and there will be plenty of verification for this prediction before the Christmas holidays. Other city shares are dull, with no change in the nominal quotations.

Brooklyn securities are lifeless, so far as actual dealing in them is concerned, but nominal values are maintained. The long delayed consolidation scheme, it is said, will shortly be perfected; that is, the details of the merger will be given to the public. This announcement, however, has been so often made that there is little likelihood just now of investors sitting up later than usual for the purpose of getting the news early.

Chicago gas was firm during the week, some transfers having been reported to-day at 61⅛; towards noon a reaction to 60⅞ occurred. These shares ought, according to the situation, have a further increase in value.

Baltimore Consolidated is steady, at 62½ to 63, and Lacledes are a trifle weaker than was the case a week ago. The bid is 26, holders asking one-half point higher.

Consumers, of Jersey City, is 91 bid, but holders are not at all disposed to accept that figure. Consumers 6's are wanted at par.

Bay State scored an advance to 20½ bid during the week. Cincinnati remains steady at 203. The situation in general seems to favor higher prices all around.

Gas Stocks.

Quotations by Close & Nash, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

AUGUST 19.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	142	143⅛
Central	500,000	50	140	..
" Scrip	220,000	..	100	..
Equitable	4,000,000	100	194¾	..
Bonds, 6's	1,000,000	1,000	106	..
" 1st Con. 5's	2,300,000	1,000	113	115
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	170½	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	.
Northern	150,000	50	90	91
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	30¾	31⅛
Preferred	2,000,000	100	54	56
Bonds	3,500,000	1,000	90½	92
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	65	68
Preferred	5,000,000	100	107	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	107	..
Yonkers	299,650	50	112	..
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	125	..
Citizens	1,200,000	20	65	..
" S. F. Bonds	320,000	1,000	..	101
Equity	2,000,000	10	..	..
" Bonds	1,000,000	..	..	..
Fulton-Municipal	3,000,000	100	175	..
" Bonds	300,000	..	103	..
Peoples	1,000,000	10	90	.
" Bonds, 7's	308,000	..	100	..
" " 6's	94,000	..	98	100
Metropolitan	870,000	100	170	..
" Bonds, 5's	70,000	..	..	..
Nassau	1,000,000	25	225	..
" Ctfs.	700,000	1,000	90	100
Williamsburgh	1,000,000	50	210	..
" Bonds	1,000,000	..	107	110
Out-of-Town Companies.				
Bay State	5,000,000	50	20½	21
" Income Bonds	2,000,000	1,000	33	..
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	..	80
2d " " "	3,000,000	1,000	51	55
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	.....	..	95	..
Chicago Gas Co.	25,000,000	100	61	61⅛
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	98	98½
Columbus	1,069,000	..	63	66
1st Mortgage	1,065,000	..	91	98
Consumers, Jersey City	2,000,000	100	91	..
" Bonds	600,000	1,000	100	..
Cincinnati G. & C. Co.	7,000,000	100	203	203¼
Consumers, Toronto	1,600,000	50	184½	187
Central, San Francisco	.....	..	95	..
Capital, Sacramento	.....	..	.	41
Consolidated, Baltimore	11,000,000	100	62¾	63
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,400,000	..	..	..
Detroit	4,000,000	..	30¾	..
" Con. Bonds	4,312,000	..	75	..
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	72	74
" Bonds	2,000,000	..	85	..
Hartford	750,000	25	120	128
Indianapolis	2,000,000	..	150	155
" Bonds, 6's	2,650,000	..	103½	..
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	85	86
Bonds	1,000,000	1,000	88	90
Louisville	2,570,000	50	.	180
Laclede, St. Louis	7,500,000	100	26	26½
Preferred	2,500,000	100	83	86
Bonds	9,084,400	1,000	98	.
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	..
New Haven	.....	25	225	..
Oakland, Cal.	.....	..	45	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175

Advertisers' Index.

GAS ENGINEERS.

	Page
Jos. R. Thomas, New York City	320
Wm. Henry White, New York City	319
Fred. Bredel, Milwaukee, Wis.	315
H. C. Slaney, Brooklyn, N. Y.	319
Geo. R. Rowland, New York City	319
The Western Gas Construction Co., Fort Wayne, Ind.	310
Humphreys & Glasgow, New York City	306
T. G. Lansden, St. Louis, Mo.	319

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md.	317
United Gas Improvement Co., Phila., Pa.	309
Burdett Loomis, Hartford, Conn.	308
National Gas and Water Co., Chicago, Ills.	311
Economical Gas Apparatus Construct'n Co., Toronto, Ont	323
The Western Gas Construction Co., Fort Wayne, Ind.	310

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd & Sons, New York City	320
Continental Iron Works, Brooklyn, N. Y.	318
Delly & Fowler, Phila., Pa.	320
Kerr Murray Mfg. Co., Fort Wayne, Ind.	310
Stacey Mfg. Co., Cincinnati, Ohio	319
Bartlett, Hayward & Co., Baltimore, Md.	317
Davis and Farnum Mfg. Co., Waltham, Mass.	316
R. D. Wood & Co., Phila., Pa.	318
Isbell-Porter Company, New York City	318
Fred. Bredel, Milwaukee, Wis.	315
United Gas Improvement Co., Phila., Pa.	309
Berlin Iron Bridge Co., East Berlin, Conn.	306
National Gas and Water Co., Chicago, Ills.	311
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	323
The Western Gas Construction Co., Fort Wayne, Ind.	310
Humphreys & Glasgow, New York City	306
Gas Engineering Co., Pittsburgh, Pa.	308

SCRUBBERS AND CONDENSERS.

G. Shepard Page's Sons, New York City	319
R. D. Wood & Co., Phila., Pa.	318
James R. Floyd & Sons, New York City	320
Continental Iron Works, Brooklyn, N. Y.	318
Gas Engineering Co., Pittsburgh, Pa.	308

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md.	317
Fred. Bredel, Milwaukee, Wis.	315
J. H. Gautier & Co., Jersey City, N. J.	315
Parker-Russell Mining and Mfg. Co., St. Louis, Mo.	314
Adam Weber, New York City	314

TAR AND CARBONIC ACID EXTRACTOR.

G. Shepard Page's Sons, New York City	319

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich.	300
G. Shepard Page's Sons, New York City	319
Gas Engineering Co., Pittsburgh, Pa.	308

GAS METERS.

John J. Griffin & Co., Phila., Pa.	284
American Meter Co., New York and Philadelphia	323
The Goodwin Meter Co., Phila., Pa.	322
Helme & McIlhenny, Phila., Pa.	323
D. McDonald & Co., Albany, N.Y.	323
Nathaniel Tufts, Boston, Mass.	322
Maryland Meter and Mfg. Co. Baltimore, Md.	322
Metric Metal Co., Erie, Pa.	321

GAS AND WATER PIPES.

Ohio Pipe Co., Columbus, Ohio	321
M. J. Drummond, New York City	321
R. D. Wood & Co., Phila., Pa.	318
Warren Foundry and Machine Co., New York City	321
Donaldson Iron Co., Emaus, Pa.	321
Addyston Pipe and Steel Co., Cincinnati, O.	320
John Fox, New York City	321

GAS BAGS.

Peerless Rubber Mfg. Co., New York City	299

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, New York City	315

GAS COALS.

Penn Gas Coal Co., Phila., Pa.	313
Perkins & Co., New York City	312
Despard Gas Coal Co., Baltimore, Md.	313
Westmoreland Coal Co., Phila., Pa.	313
Shaner Coal Co., Philadelphia, Pa.	300
Berwind-White Coal Mining Co., New York and Phila.	312
Henry C. Scheel, New York City	313

CANNEL COALS.

Perkins & Co., New York City	312
Log Mountain Coal, Coke and Timber Co., Pineville, Ky.	313
The Goff-Kirby Coal Co., Cleveland, O.	312
Henry C. Scheel, New York City	313
Thos. N. Mordue, New York City	300

GAS ENRICHERS.

Standard Oil Co., New York City 313
The Sun Oil Co., Pittsburgh, Pa 313
W. H. Townsend, New York City 313

COKE CRUSHER.

C. M. Keller, Columbus, Ind 313

CONVEYING MACHINERY.

C. W. Hunt Company, N. Y. City 304

GAS GAUGES.

The Bristol Co., Waterbury, Conn 299

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City. 311
Wilbraham Baker Blower Co., Phila., Pa 311
Isbell-Porter Co., New York City 318

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Company, New York City 318
Continental Iron Works, Brooklyn, N. Y 318
G. Shepard Page's Sons, New York City 319

RETORTS AND FIREBRICK.

J. H. Gautier & Co., Jersey City, N. J 314
B. Kreischer & Sons, New York City 314
Adam Weber, New York City 314
Laclede Firebrick Mfg. Co., St. Louis, Mo 314
Cyrus Borgner, Phila., Pa 314
James Gardner, Jr., Pittsburgh, Pa 314
Henry Maurer & Son, New York City 314
Baltimore Retort and Firebrick Co., Baltimore, Md 314
Parker-Russell Mining and Mfg. Co., St. Louis, Mo 314
Brooklyn Firebrick Works, Brooklyn, N. Y 314
F. Behrend, New York City 304

CEMENTS.

C. L. Gerould & Co., Mount Vernon, N. Y 314
F. Behrend, New York City 304

INCANDESCENT GAS LAMPS.

Welsbach Light Co., Gloucester, N. J 303

MICA GOODS.

The Mica Mfg. Co., New York City 300

BURNERS.

C. A. Gefrorer, Phila., Pa 318
Moses G. Wilder, Phila., Pa 300

LAVA GAS TIPS.

D. M. Steward Mfg. Co., Chattanooga, Tenn 299

GAS TUBING.

New York Gas Tubing Co., New York City 300

STREET LAMPS.

J. G. Miner, Morrisania, New York City 315
Bartlett Lamp Mfg. Co., New York City 315

PURIFYING MATERIALS.

Connelly Iron Sponge and Governor Co., New York City 311
Greenpoint Chemical Works, Brooklyn, N. Y 311
Henry W. Douglas, Ann Arbor, Mich 311
Read, Holliday & Sons, Ltd., New York City 304

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind 308
Isbell-Porter Company, New York City 318
Wilbraham Baker Blower Co., Philadelphia, Pa 311
Connelly Iron Sponge and Governor Co., New York City 311

VALVES.

Ludlow Valve Manufacturing Co., Troy, N.Y 310
Chapman Valve Manufacturing Co., Boston, Mass 310
R. D. Wood & Co., Phila., Pa 318
Continental Iron Works, Brooklyn, N. Y 318
John Fox, New York City 321
The P. H. & F. M. Roots Co., Connersville, Ind 308
Isbell-Porter Co., New York City 318
Th Western Gas Construction Co., Fort Wayne, Ind 310

ELECTRICAL APPARATUS.

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Keystone Meter Co., Royersford, Pa 309

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F. A. Wilke, Richmond, Ind 320
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Wm. Cox, Stapleton, N. Y 317

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Alvord & Co., Detroit, Mich 216

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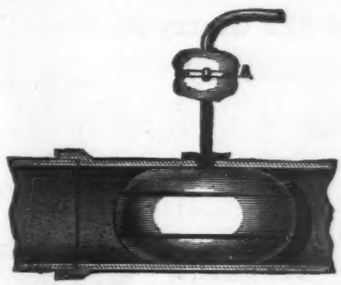

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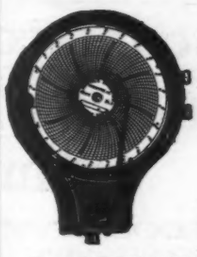

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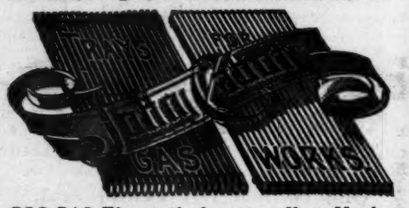

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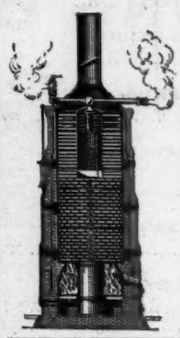

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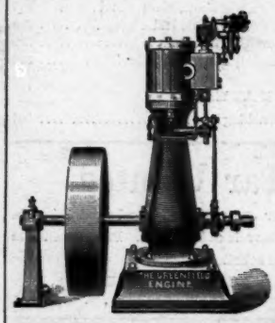

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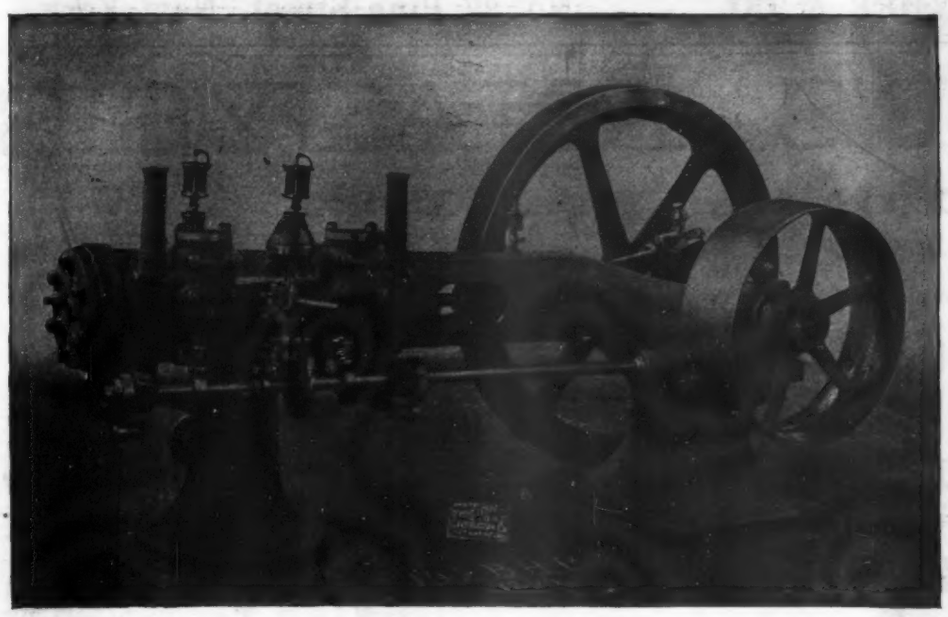

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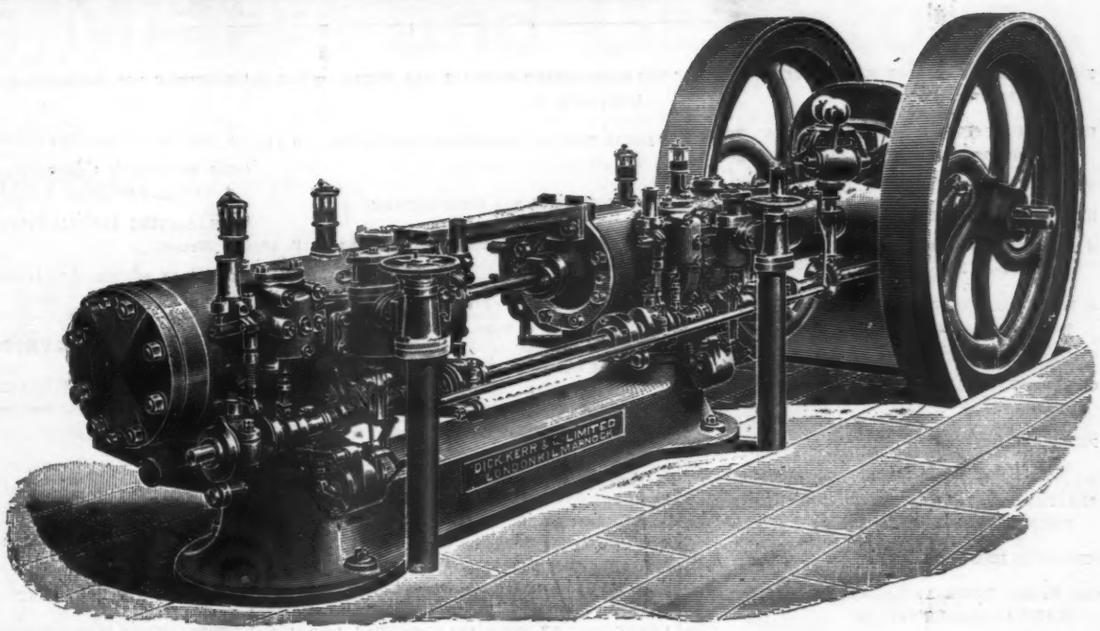

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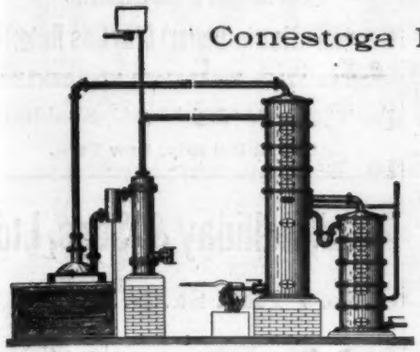

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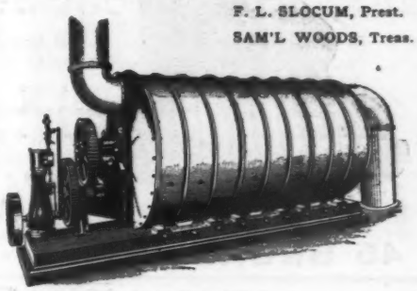

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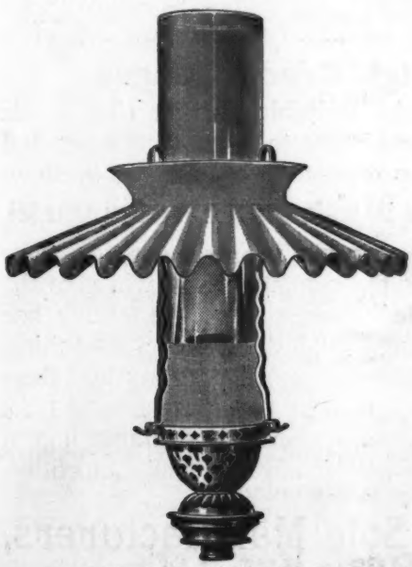

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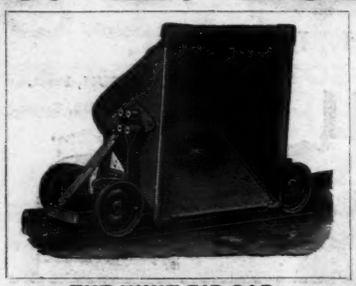

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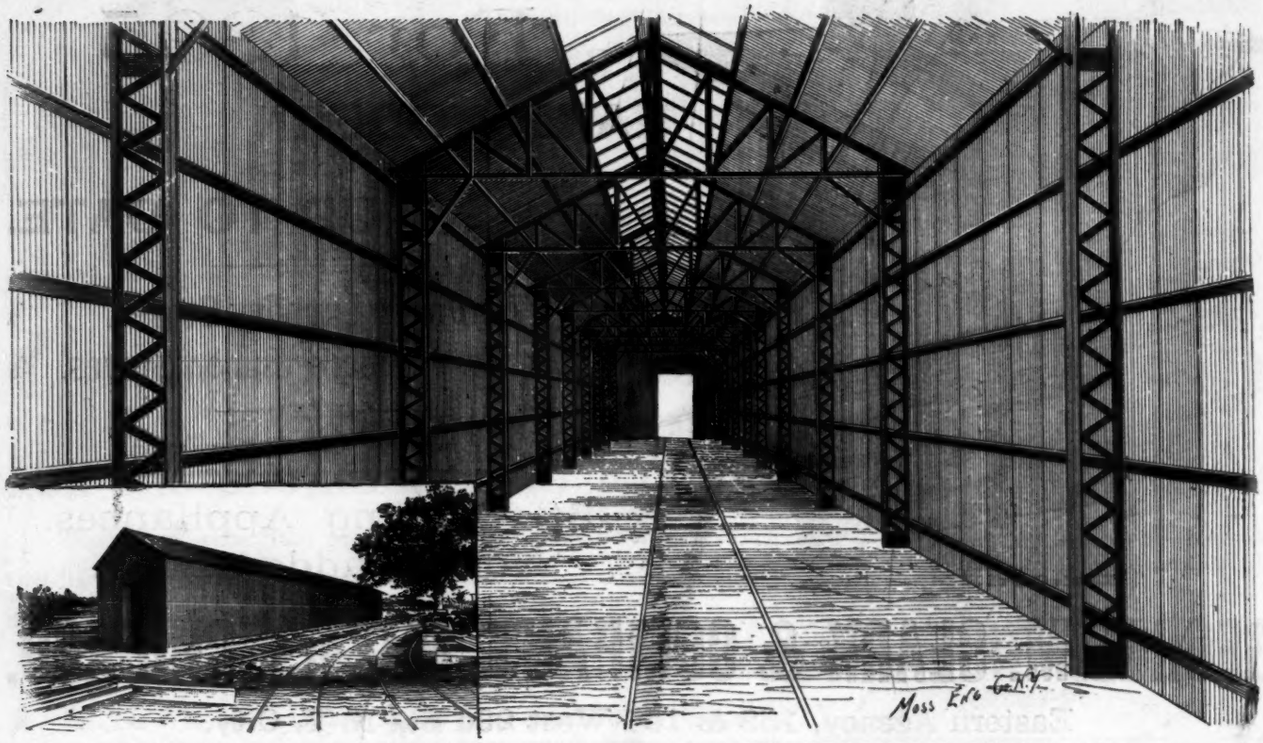

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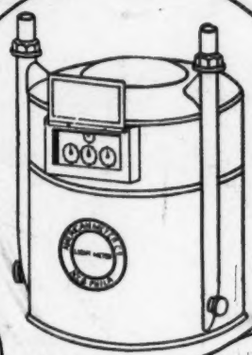
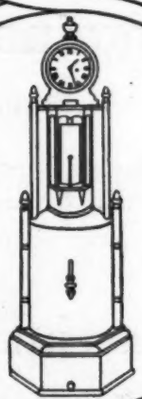
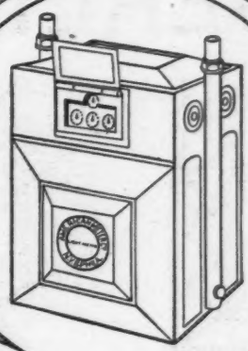
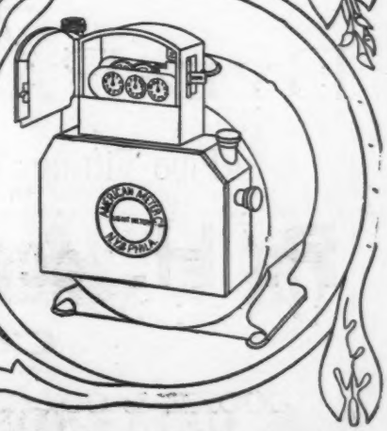








PUBLIC LIGHTING TABLE.

SEPTEMBER, 1895.

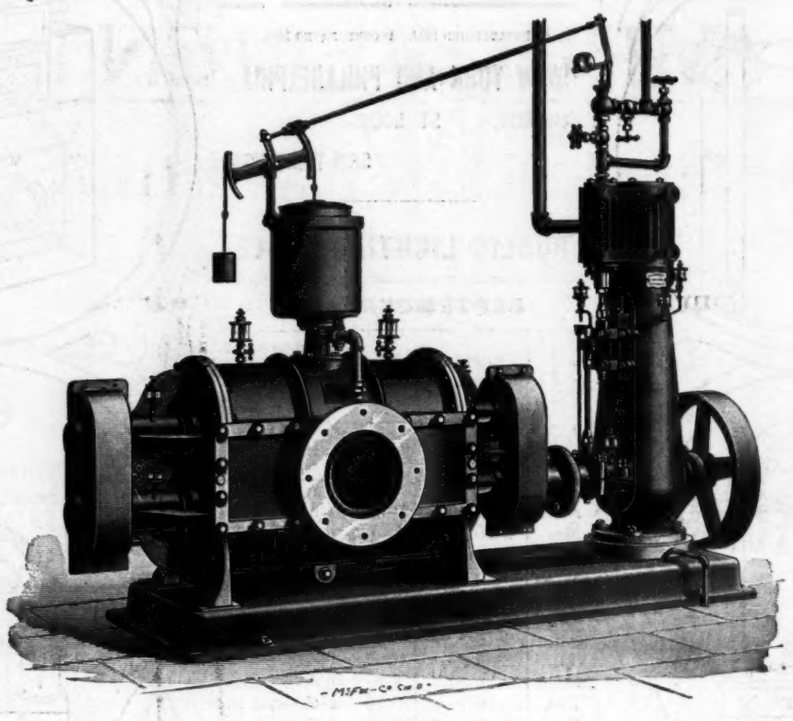
Day of Week.	Table No. 1. FOLLOWING THE MOON.			Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING.	
	Date.	Light.	Extinguish.	Light.	Extinguish.
				P.M.	A.M.
Sun.	1	2.40 AM	4.30 AM	6.30	4.20
Mon.	2	No L.	No L.	6.30	4.20
Tue.	3	No L. FM	No L.	6.15	4.30
Wed.	4	No L.	No L.	6.15	4.30
Thu.	5	6.50 PM	8.00 PM	6.15	4.30
Fri.	6	6.50	8.20	6.15	4.30
Sat.	7	6.50	8.40	6.15	4.30
Sun.	8	6.50	9.00	6.15	4.30
Mon.	9	6.50	9.30	6.15	4.30
Tue.	10	6.50	10.10	6.05	4.40
Wed.	11	6.50 LQ	10.50	6.05	4.40
Thu.	12	6.50	11.50	6.05	4.40
Fri.	13	6.50	1.00 AM	6.05	4.40
Sat.	14	6.50	2.20	6.05	4.40
Sun.	15	6.30	4.40	6.05	4.40
Mon.	16	6.30	4.40	6.05	4.40
Tue.	17	6.30	4.40	5.55	4.50
Wed.	18	6.30 NM	4.40	5.55	4.50
Thu.	19	6.30	4.40	5.55	4.50
Fri.	20	6.30	4.40	5.55	4.50
Sat.	21	6.30	4.40	5.55	4.50
Sun.	22	6.30	4.50	5.55	4.50
Mon.	23	7.40	4.50	5.55	4.50
Tue.	24	8.30	4.50	5.40	5.00
Wed.	25	9.30 FQ	4.50	5.40	5.00
Thu.	26	10.30	4.50	5.40	5.00
Fri.	27	11.30	4.50	5.40	5.00
Sat.	28	12.30 AM	4.50	5.40	5.00
Sun.	29	1.40	5.00	5.40	5.00
Mon.	30	2.40	5.00	5.40	5.00

TOTAL HOURS LIGHTING DURING 1895.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	237.00	January	423.20
February	196.40	February	355.25
March	195.50	March	355.35
April	165.30	April	298.50
May	153.40	May	264.50
June	138.20	June	234.25
July	146.30	July	243.45
August	152.50	August	280.25
September	165.10	September	321.15
October	186.10	October	374.30
November	204.10	November	401.40
December	219.30	December	433.45
Total, yr.	2161.20	Total, yr.	3987.45

ROOTS' LATEST IMPROVED EXHAUSTER.

Our Latest Improved **Automatic Gas Governor** and **Steam Bye-Pass Valve** are the best in the market.



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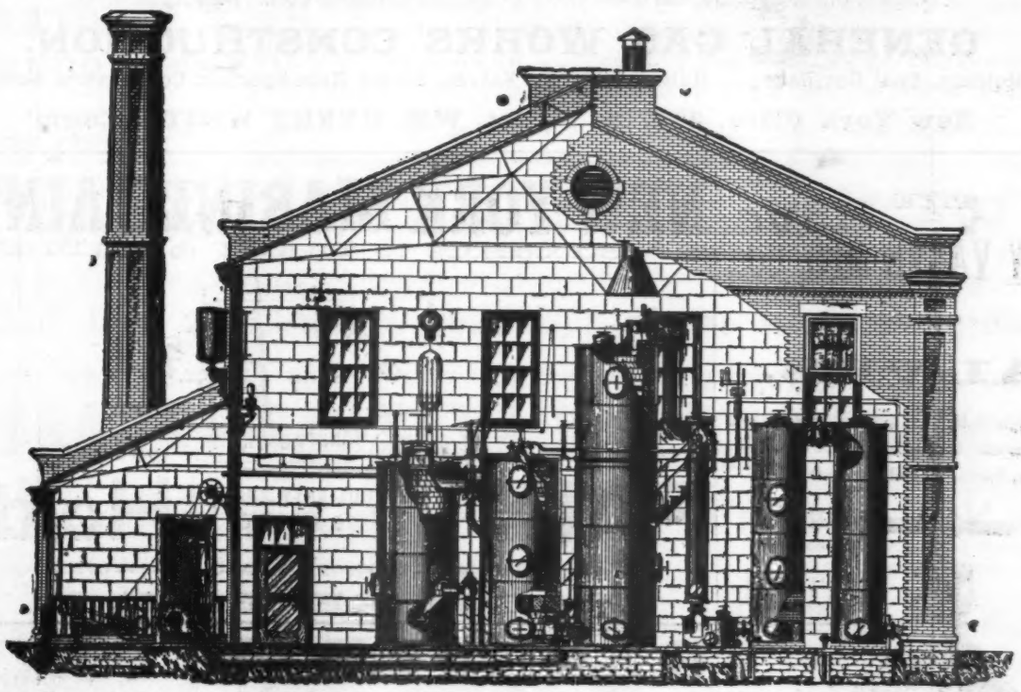

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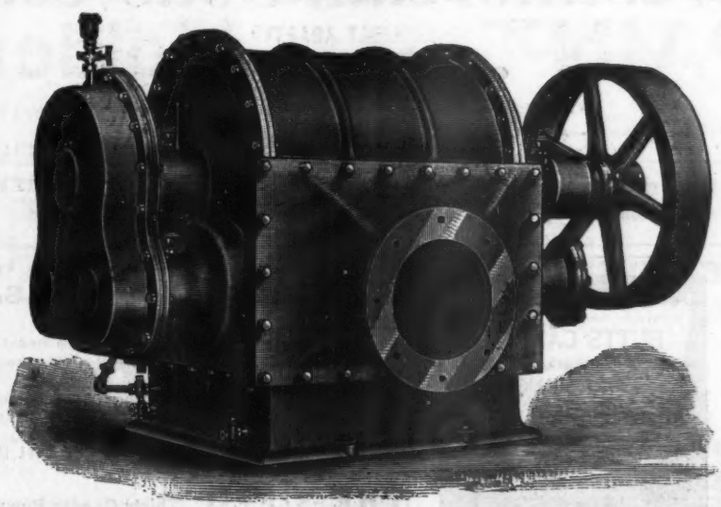

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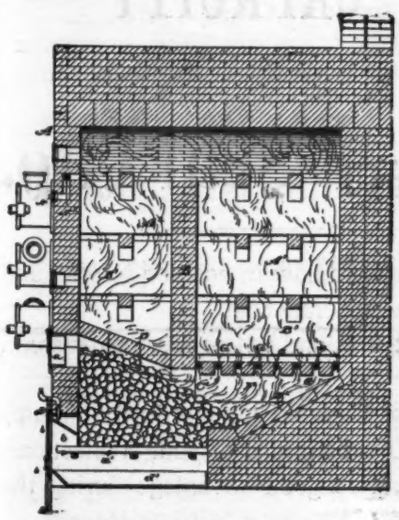

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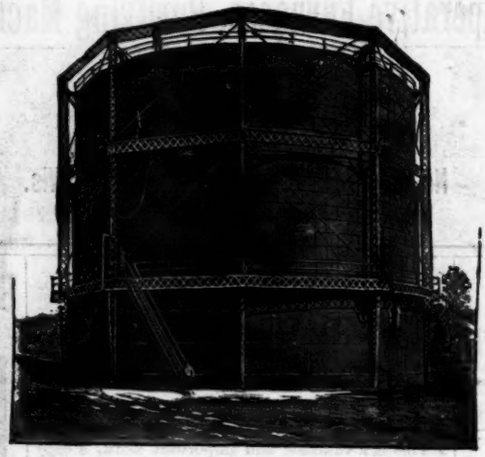

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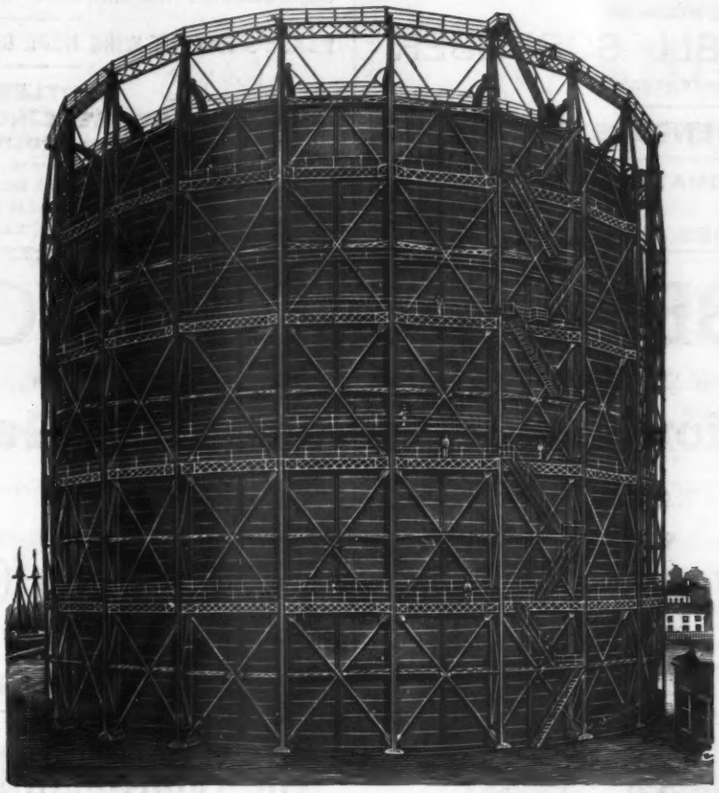

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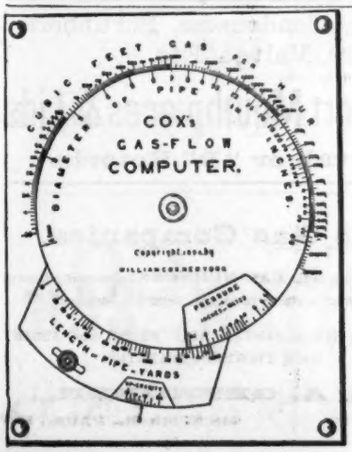

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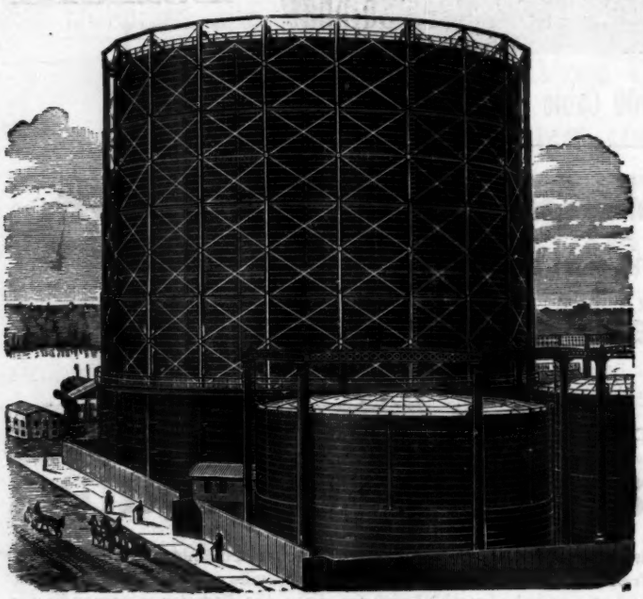

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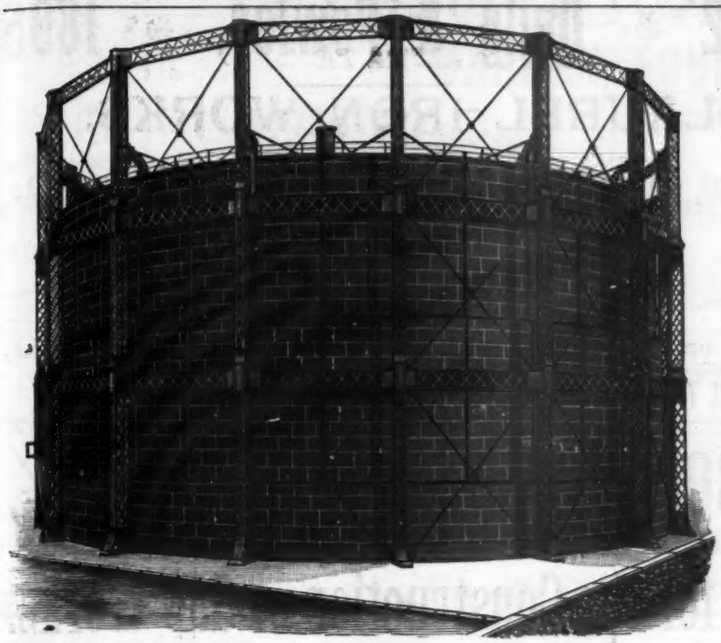

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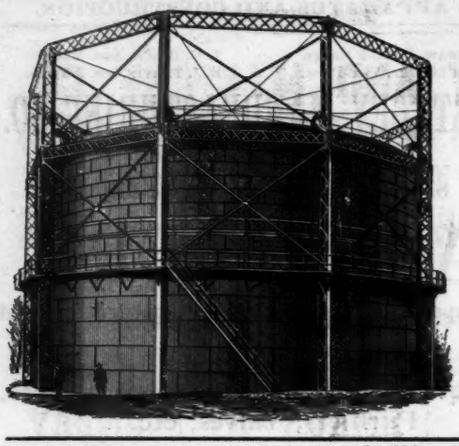

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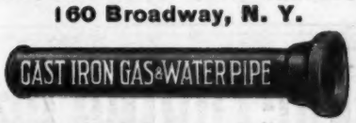

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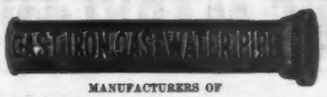

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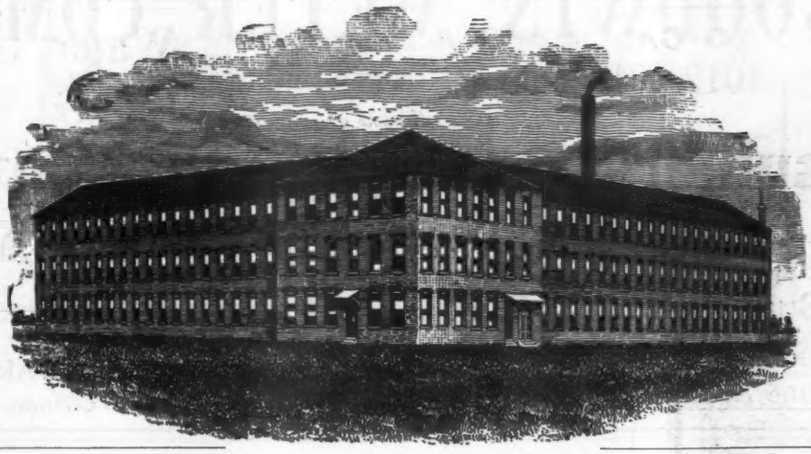

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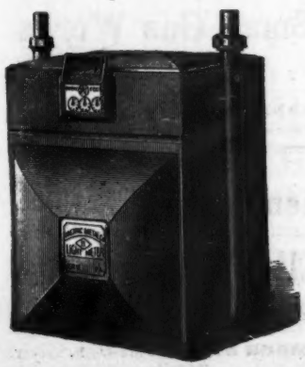

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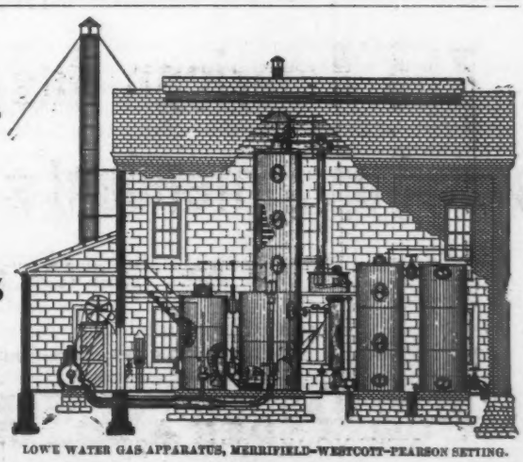

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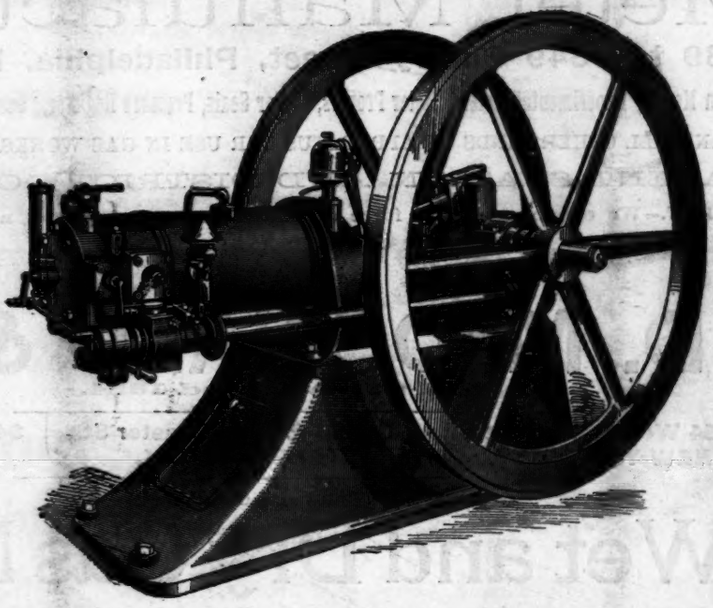

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